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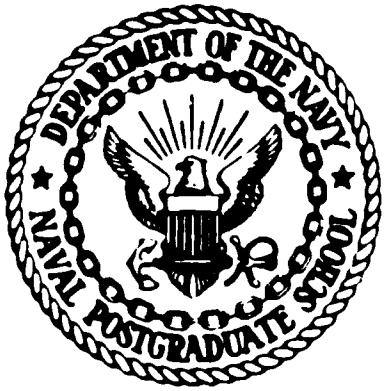
Monterey, California



THESIS

COMPUTER PROGRAM
FOR
CONCEPTUAL TANDEM ROTOR HELICOPTER DESIGN

by

Bruce A. Vandenbos

September 1987

Thesis Advisor: D. M. Layton

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This program manages the myriad of interrelated parameters by prompting for input, providing the opportunity for changes, and displaying the results. This relieves the designer of the tedious calculations and bookkeeping, thus allowing time for a more thorough analysis of the design.

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Computer Program for Conceptual Tandem Rotor Helicopter Design

by

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

The conceptual phase of a helicopter design includes comparison of configurations which will meet the specified performance requirements. To perform this comparison, the designer must have the proper tools at hand. This thesis presents an interactive computer program for the conceptual design of tandem rotor helicopters. It is intended to complement the existing single rotor helicopter design program written for the Helicopter Design course, AE-4306, taught at the Naval Postgraduate School, Monterey, California.

This program manages the myriad of interrelated parameters by prompting for input, providing the opportunity for changes, and displaying the results. This relieves the (student) designer of the tedious calculations and bookkeeping, thus allowing time for a more thorough analysis of the design.

TABLE OF CONTENTS

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No acknowledgement would be complete without expressing one's gratitude to the family who must endure such an undertaking. So, I extend a special thanks to my wife, Rachel, who's selfless devotion of time and energy are greatly appreciated.

I. INTRODUCTION

A. BACKGROUND

Helicopter Design, AE-4306, as taught at the Naval Postgraduate School requires the "Conceptual Design" of a specific mission-capable helicopter as one of the course requirements.

Conceptual Design is the first of five phases where configurations are compared; cost, weight and size are estimated; feasibility is studied; and then follow-on recommendations are made [Ref. 1]. It is the first of these, comparison of configurations, which prompted this thesis.

Tandem rotor helicopters have been successfully employed since March of 1945 when the PV-3 Dogship was developed for the U.S. Navy. As with all else in aviation, humble beginnings give way to technology and ingenuity, so that by the mid 1960's, Boeing Vertol had developed the H-46 Sea Knight and H-47 Chinook. Both are still currently in use, flying today in all four U.S. armed services, various commercial operations (logging, oil production, etc.) as well as servicing in other countries such as Japan, Canada, Great Britain and Sweden.

To the casual observer the appeal of the tandem rotor scheme is obvious--both rotors provide thrust in the correct direction (up) and therefore a fraction of the power isn't wasted pushing the helicopter sideways, as in the tail rotor configuration. Although somewhat true, this observation does require clarification. Tail rotors typically absorb 10 to 20 percent of the engine power required to hover [Ref. 2]. This decreases in forward flight because of translational lift effects which produce a decrease in main rotor

torque. This provides a slight reduction in tail rotor power. Tandems also have a power penalty due to interference effects found where the two rotor disks overlap. Analytically, this is accounted for by correcting induced power with a "rotor interference factor", K, which has been determined empirically to be a function of the rotor shaft spacing ratio [Ref. 3 and Ref. 4]. For forward flight, another factor must be included, K_u, the "induced power correction factor". A combination of these factors results in losses comparable to those of the tail rotor configuration, depending on the regime of flight. It is noticeable that tandems appear better in hover and low forward velocities with the single rotor having advantages at medium to high forward velocity. However, these apparent respective advantages are not clearly defined, nor are they easily quantified.

Reference [5] is an interactive program for conceptual helicopter design, but is restricted to the single rotor configuration. This thesis project sought to complete the designer's "tool box" with the development of a Tandem Rotor Helicopter Design program. Configuration selection could then be based upon design superiority and mission requirement rather than philosophical whim.

Aside from the nebulous factors discussed above, there are distinct advantages and disadvantages to a tandem rotor system. Some advantages of the tandem rotor design are:

- Anti-torque is encumbent in the counter-rotating rotor system.
- No tail rotor losses or side force that require compensation.
- Lighter drive system due to smaller diameter, higher rpm rotors (therefore less speed reduction).

- Much larger range in center of gravity locations.
- Relatively small effect of wind direction on hover capability. [Ref. 2]

As important as the advantages of a given system are, its limitations must be considered also. Disadvantages, relative to single rotor systems, are:

- Greater directional instability, due to decreased distance from center of gravity position to tail surface.
- High moment of inertia about the vertical axis due to transmission mass located at each end.
- Higher induced power required on aft rotor due to the forward rotor downwash.
- Vibration--twice as many rotors tend to produce greater vibration problems than a single rotor configuration. [Ref. 2]

Although some of these are significant problems, none are insurmountable. Furthermore, the technological developments of the past 20 years are updating the previous solutions to these design problems with current computer and material technology. For example, the Army is currently updating its H-47 fleet to the "D" model Chinook and the Navy and Marine Corps are upgrading their H-46's through the Survivability, Reliability and Maintainability (S R & M) program. Both programs are intended to extend service life well into the next century.

B. OBJECTIVES

The primary objective of this thesis project was to write a computer program for the conceptual design of tandem rotor helicopters. Secondary goals included: interactivity for design flexibility; user friendliness so people will use it; compactness, for microcomputer application; and accuracy so the results are meaningful. All of this required the development of a substantial amount of program software.

The program will be available to students taking the Helicopter Design course, AE-4306. This will provide the option to easily design a helicopter of either rotor system scheme depending on the specific mission that it will be required to perform.

II. APPROACH AND SOLUTION

The initial intent of this project was to integrate a tandem rotor design section into the existing Helicopter Design program written by LT Bob Drake [Ref. 5]. This, however, proved hopeless as the differences in design, equations, input and output became apparent. The problem then became to develop the program in a format compatible with reference 5, but be totally independent.

"User friendliness" is a key phrase commonly heard these days in the computer business, and with good reason. People want to use the computer as a tool to accomplish a given task without themselves becoming a slave to the green screen and microchip. To this end, Tandem Rotor Helicopter Design was written as a menu driven, interactive program that would, to the maximum extent possible, trap errors and return to a menu or input field without terminating the program.

Microsoft GWBASIC was chosen as the language, not only to be consistent with Reference 5 but also because of its compatibility with IBM, and all true compatibles. Furthermore, since there was only a small amount of serious number crunching to be done, vast speed was not required; hence, GWBASIC was the logical choice.

The program is formatted into a sequence of chapters that roughly correspond to the Helicopter Design Manual [Ref. 1]. Although tandems are different in some respects, they share many similarities with their single rotor cousins. Therefore, the program references the design manual frequently, and also provides additional, tandem rotor specific, information when appropriate. This provides the student designer

hard copy reference material to complement the "information" and "help windows" that are built into the program.

Each chapter is designed to run as a follow-on to the previous, with provisions to make changes if desired. New data is then entered, when prompted, into specific input fields. When data entry is complete the computer will calculate the results and display them on an output field, usually on the same screen, so that input and output can be viewed simultaneously. The "ANY CHANGES?" prompt will then appear allowing the adjustment of parameters to meet design specification. Once a design is refined, a print-screen command gives a hard copy of the results, then the appropriate menu selection proceeds to the next section or returns to the main menu. All chapters are linked via the "chain" command which not only passes control and executes the next program, but also passes all variables.

One important feature of this program is the use of FLASHUP WINDOWS^{R} [Ref. 6] to display menus, information and help to the user. This outstanding application software allows addition of useful documentation that can be easily accessed by the user. By simply pressing ALT-F1, with the cursor on the appropriate line, a "help window" will be displayed for each major input parameter, pressing "Enter" clears the window and returns to the input line. Information windows will display automatically when a particular chapter or section is selected and will remain as long as desired. Again, "Enter" clears the window and proceeds with the program. Menus function in much the same fashion, except that they remain until the user makes a selection, either by pressing the first character (letter or number) in the menu line or by using the

"up"-"down" arrow keys to highlight the item then pressing "Enter" to execute the selection.

For this project the Helicopter Design Manual [Ref. 1] and Helicopter Performance [Ref. 3] were the primary source of equations. In addition, several other resources were tapped in the development of the analytical routines of the program. Power requirements for tandems are computed using equations developed from a combination of momentum theory and test data. This set of semi-empirical equations was found to be the most accurate when compared to actual H-46 and H-47 test data [Ref. 4]. Weight estimation used parametric equations, specially developed for tandem rotor helicopters in [Ref. 7].

III. RESULTS

Conceptual helicopter design is based on a myriad of interrelated parameters which constantly require changes and iteration to meet the design specification. This program handles the tedious calculations and bookkeeping allowing the designer to delve deeper into the intricacies of the design. Thus the engineer will spend his time evaluating options, optimizing parameters or conducting trade-off studies, instead of performing mindless hand calculations. Furthermore, this program is designed to teach, as well as being a tool. The optional "help windows" and information screens all serve to help the novice helicopter designer learn the process. Once the process is learned, the designer can quickly refresh his memory without interrupting the continuity of the program. In short, the Tandem Rotor Helicopter Design program complements existing software, is easy to use, and gives excellent results for Conceptual Design.

Appendix A contains the "user's guide" to the program. It is intended to help students get started and use the program regardless of their experience level with personal computers.

Appendix B shows results for a conceptual design of a helicopter with design parameters similar to those of the H-46.

Appendix C is the program listing.

IV. CONCLUSIONS AND RECOMMENDATIONS

Computer assisted design is a rapidly expanding aspect of the engineering world--and with good reason. Virtually all aspects of design are easier, faster and more accurate with the advent of the modern digital computer. Furthermore, microcomputers have become so common that the power of the computer is available to virtually everyone.

Tandem Rotor Helicopter Design is a small addition to the vast amount of software that is being developed. With it, the student can work through the conceptual design of several helicopters in a fraction of the time that it previously took for just a single design.

It is recommended as a follow-on to this thesis that graphics routines be integrated into the program that will plot directly the important relationships between parameters. For example, the Power -vs- Velocity graph which shows induced, profile, parasitic, as well as total power and high speed effects could be plotted directly from the results produced in chapter 5. This would provide an immediate visual presentation of how the design should perform.

Another recommendation would be the addition of a "blade optimization" routine similar to the one in the Single Rotor Helicopter Design program [Ref. 5]. This program however, should run separately from the remainder of the program since blade optimization is more "detailed" than "conceptual" design.

Finally it is recommended that microcomputers receive more emphasis in the Aeronautical Engineering curriculum. A course that includes an introduction to personal computers as well as basic operation procedures would be of great value to the students.

APPENDIX A

TANDEM ROTOR HELICOPTER DESIGN USER'S GUIDE

1. INTRODUCTION

This program is designed as a menu driven, interactive design tool that will perform the bookkeeping and iterative calculations required in a conceptual design. Since no tandem rotor design manual is available, information screens are displayed automatically when amplifying information was deemed appropriate. These will remain until the "Enter" key is pressed to continue. Also available, in most chapters, are "help windows" which are not normally displayed but are there if required. A notice (ALT-F1 for help) will appear to the right of the title if "help" is available. These "help windows" can be accessed by first locating the cursor on the corresponding input line, then press the "Alt" and "F1" keys (ALT-F1). Pressing "Enter" clears the window and restores program execution. Finally the Helicopter Design Manual [Ref. 1] is referenced extensively throughout the program. Though not totally compatible with tandem design, the program does follow this design manual where possible. Thus, the Tandem Rotor Helicopter Design program complements the Helicopter Design Manual [Ref. 1] with additional tandem rotor specific information.

2. BASICS

a. HARDWARE

COMPUTER: IBM PC or compatible with 128K of RAM.

MONITOR: Color if possible, but monochrome will work.

PRINTER: Any that will respond to the "Shift-PrtSc" option.

b. GETTING STARTED

Place the program disk into drive A and turn on the computer. The "system" as well as all other support software are on the disk for user convenience. The program will be loaded and run automatically, so relax and let the system work. If the computer is on, just insert the disk and press the CTRL-ALT-DELETE keys simultaneously to reboot the system.

c. USING THE PROGRAM

The main menu is the first display seen and will serve as a road map for progressing through the program. At the end of each chapter, control will be transferred back to the main menu to select the next option or quit if so desired. Selections can be made in one of two ways. First, use the up-down arrow keys to move the cursor to highlight the desired item, then press "Enter". The second option is to simply press the first letter or number key of the desired menu item; program execution will begin immediately.

Once established within a chapter, follow the prompts and input the data as requested. If a mistake is made -DON'T WORRY- the opportunity will be provided to change any item once all data is entered. Note that some variables require a positive, non-zero value. If zero or a negative number is entered a window will appear to advise you of the error. Press "Enter" to clear the window and then enter the correct number. A similar window appears if an error is made when

selecting an item to change. Again, press "Enter" and continue.

Each chapter is organized into a series of spread sheet type screens that show input and output together (if possible). When the input parameters have met the requirements, press the Shift-PrtSc keys simultaneously for a hard copy.

d. SPECIAL INSTRUCTIONS

This section provides a brief synopsis of each chapter in the program. Each chapter correlates, by number, directly to a corresponding chapter in the Helicopter Design Manual [Ref. 1], with one notable exception; Chapter 4 is reserved for a future blade optimization program since tail rotors don't really fit into the tandem rotor design scheme.

(1) CHAPTER ONE

This contains a brief introduction and is included for those who do not have access to this user's guide.

(2) CHAPTER TWO

Chapter Two performs the preliminary rotor design for the helicopter. This follows the Helicopter Design Manual [Ref. 1] in determining the major parameters that will effect the eventual performance of the helicopter. Note that one rotor is designed to carry half the gross weight and the two rotor system is assembled in Chapter Three.

(3) CHAPTER THREE

This is the Tandem Rotor System Design segment of the program where two identical counter-rotating rotors are put together as a system. Any of the 13 input variables can be adjusted to observe its effect on power, figure of merit, disk loading, etc. When

these are acceptable, proceed to the weight estimation portion of the program.

Weight estimation is based primarily on power required, but power is a function of weight, hence an iterative process. As with previous sections, input the requisite information at the prompts and the computer does the rest.

(4) CHAPTER FOUR

Blade optimization is to be included at a later date.

(5) CHAPTER FIVE

This chapter incorporates the effects of retreating blade stall, advancing blade shock losses, high altitude hover, and various survivability/safety additions to the total power required. Total power required will be needed to select the engines in the next chapter.

(6) CHAPTER SIX

Engine and transmission selection are the topic of this chapter. To complete the analysis, specific engine data is required. Table VI-1 in the Helicopter Design Manual [Ref. 1] provides a summary of six generic engines that are representative of currently available, power plants. If a specific manufacturer's data is available it too can be used.

(7) CHAPTER SEVEN

This section computes the range and endurance for the helicopter being designed. Chapter 7 should be reviewed before beginning. Once the data is entered it will take a few minutes to solve the equations, so be patient; the computer will beep when it is done.

(8) CHAPTER EIGHT

This chapter is reserved to calculate all of those requirements that don't fit elsewhere. Due to

the differences between tandem and single rotor design some of these are completed in earlier chapters. Check the design gross and empty weight as determined back in Chapter 3.

Maximum hover altitude was specified back in Chapter 5 and used in determining engine power required. However, the maximum power is often in forward flight, thus a higher than specification hover ceiling will be available.

(9) CHAPTER NINE

This provides a final summary of the helicopter's designed performance and geometric parameters.

(10) CHAPTER TEN

Chapter 10 computes an estimate of cost based on a set of parametric equations that incorporate component weights (Chapter 3), the inflation rate and expected production quantity.

```
                    * PRELIMINARY ROTOR DESIGN *

 1. DESIGN MAX GROSS WEIGHT [lbs] (2.1) .........MGW = 23000
 2. ESTIMATE OF EMPTY WEIGHT [lbs] (2.2) .........MTW = 12000
 3. ROTOR TIP VELOCITY (2.3; 700 fps recommended) VT = 700
 4. DISC LOADING [lbs/ft^2] (2.4 ; FIG. 2-2)  ....DL = 5.7
    ROTOR RADIUS  [ft] (2.4).............R =   25.3418
    ROTATIONAL VELOCITY [rpm] ..........RPM =  263.7940
    THRUST COEFFICIENT  (2.6)...........CT =    0.0049
 5. SPECIFICATION MAX AIRSPEED [knots] (2.7) ..TASMX = 150
    ADVANCE RATIO (2.7) .................MU =    0.3619
 6. MAX BLADE LOADING (2.7; FIG.2-3; CT/S) ......MBL = .09
    ROTOR SOLIDITY (2.7) .................S =    0.0544
 7. NUMBER OF ROTOR BLADES PER HEAD  (2.8).........B = 3
    BLADE CHORD [ft] (2.9) ..............C =    1.4431
    ASPECT RATIO (2.9) ..................AR =   17.5609
    AVG LIFT COEFF (2.10) ..............CL =    0.5400

 8. RETURN TO MAIN MENU.

     WHICH PARAMETER DO YOU WISH TO CHANGE / SELECT ? 8

*** FOR HARD COPY PRESS <Shift-PrtSc> BEFORE RETURNING TO MAIN MENU ***
```

```
                    * TANDEM ROTOR SYSTEM DESIGN *          (Alt-F1 for help)

 1. DESIGN MAX GROSS WEIGHT  [lbs].............MGW =  23000.0
 2. ROTOR RADIUS  [ft].........................R =     25.3
 3. BLADE CHORD  [ft] .........................C =      1.4
 4. BLADE PROFILE DRAG COEFFICIENT ............CDO =   0.0090
 5. NUMBER OF ROTOR BLADES PER HEAD ...........B =      3
 6. OPERATING RPM  [rpm] ......................RPM =    263.8
 7. ROTOR SHAFT SPACING  [ft] .................S1 =     33.8
 8. ROTOR HEAD VERTICAL SPACING  [ft] .........GAP =     4.0
 9. HEIGHT OF FORWARD HEAD ABOVE WHEELS [ft] ....FHH =    12.0
10. PRESSURE ALTITUDE  [ft  MSL] .............PA =      0
11. HOVER ALTITUDE  [ft  AGL] ................AGL =     10
12. TRUE AIRSPEED [knots] (0 FOR HOVER) ......TAS =      0
13. EQUIVALENT FRONTAL AREA  [ft^2] ..........FF =     44.0
14. COMPONENT WEIGHT ESTIMATES  15. RETURN TO MAIN MENU
                          -- RESULTS --
      PI =  1209.82                    FM =   0.77  (.75 to.85) *HOVER
      PO =   365.92                    DL =   4.20  ( 5 to 15 )  ONLY
      PP =     0.00                    CL =   0.42  (CLmax; 1.55)
                                       AR =  17.56  ( 15 to 20 )
      PT =  1575.75  HP                BL =  0.070  (BLmax; 0.12)
  WHICH PARAMETER DO YOU WISH TO SELECT / CHANGE ? 15
```

* COMPONENT WEIGHT APPROXIMATIONS * (Alt-F1 for help)

1. TYPE LNDG GEAR (TRICYCLE STYLE)
   1=FIXED 2=RETRACTABLE 1
2. NUMBER OF ENGINES (2 or more) ... 2
3. ESTIMATED FUEL CAPACITY (lbs).... 2600
4. NUMBER OF CREW AND PASSENGERS ... 25
5. WT OF SPECIAL AVIONICS (lbs) 120
6. SPECIFICATION USEFUL LOAD (lbs) . 1800
7. RETURN TO TANDEM ROTOR SYSTEM DESIGN

SELECTION ? (1 thru 6 for changes)

SPEC MAX GROSS WT (MGW)	= 23000.0 lbs
NEW A/C EMPTY WT	= 12093.4
FUEL WT	= 2600.0
PERSONNEL WT	= 6250.0
USEFUL LOAD	= 1800.0
NEW GROSS WT ESTIMATE	= 22743.4 lbs
TOTAL POWER FOR HOVER	= 2023.9 SHP

* COMPONENT *	* WEIGHT
1. MAIN ROTORS	2554.9
2. FUSELAGE	3097.2
3. LANDING GEAR	577.1
4. ENGINE NACELLES	201.4
5. ENGINES	844.3
6. DRIVE TRAIN	1479.8
7. FUEL TANKS	323.9
8. FLIGHT CONTROLS	717.1
9. AUX POWER (APU)	139.0
10. INSTRUMENTS	131.8
11. HYDRAULIC SYSTEM	86.5
12. ELECTRICAL SYSTEM	492.8
13. AVIONICS	445.0
14. FURNISHINGS	681.7
15. AC / DE-ICE EQUIP	145.9
16. LOAD HANDLING EQUIP	175.1
TOTAL COMPONENT WEIGHT	= 12093.4

* press <Shift-PrtSc> for hard copy *

```
      * HIGH SPEED EFFECTS AND POWER SUMMARY *  (Alt-F1 for HELP)

 1. GROSS WEIGHT  [lbs] .........................GW =  23000.0
 2. ROTOR RADIUS  [ft]...........................R =     25.3
 3. BLADE DATA:  CHORD  [ft] ....................C =      1.4
 4.       PROFILE DRAG COEFFICIENT ..............CDO =   0.0090
 5.       LIFT CURVE SLOPE [per RAD] .........CLALFA = 5.73
 6.       STALL ANGLE OF ATTACK  [deg] ........AOAST = 12
 7.       GEOMETRIC TWIST [deg with sign] .....TWIST = -8
 8.       CRITICAL MACH NUMBER ..................MCRT = .73
 9. NUMBER OF ROTOR BLADES PER HEAD ..............B =      3
10. OPERATING RPM  [rpm] .......................RPM =    263.8
11. ROTOR SHAFT SPACING  [ft] ....................S1 =     33.8
12. ROTOR HEAD VERTICAL SPACING  [ft] ...........GAP =      4.0
13. HEIGHT OF FORWARD HEAD ABOVE WHEELS [ft] ....FHH =     12.0
14. SPEC PRESSURE ALT [normally 4000 ft MSL]..PASPEC = 4000
15. HOVER ALTITUDE  [ft  AGL] ..................AGL =     10
16. SPEC CRUISE AIRSPEED  [knots] .............TASCR = 130
17. SPEC MAX AIRSPEED [knots] .................TASMX =    150
18. EQUIVALENT FRONTAL AREA  [ft^2] ..............FF =     44.0
19. SPEC MAX HOVER ALTITUDE (IGE) [ft] ........MXHVR = 10000
20. COMPUTE NEW POWER REQUIREMENTS   21. RETURN TO MAIN MENU
      press <Shift-PrtSc> for hard copy, ENTER to continue
```

* TOTAL POWER (SHP) REQUIRED WITH HIGH SPEED EFFECTS *

TAS(kts)	PI	PO	PP	PS	PM	PT
0	1398	366	0	0	0	1763
20	1332	370	4	0	0	1705
40	1170	381	29	0	0	1580
60	966	399	99	0	0	1464
70	870	411	157	0	11	1449
80	784	425	235	0	75	1519
100	646	458	458	0	207	1769
120	545	498	792	0	349	2183
130	504	521	1006	168	425	2624
140	469	545	1257	400	505	3177
150	439	572	1546	692	591	3839
160	412	600	1876	1058	683	4629
180	367	663	2671	2077	887	6664

MINIMUM POWER = 1,449 SHP AT 70 knots
MAXIMUM POWER = 3,839 SHP AT 150 knots
POWER AT HOVER CEILING = 1,926 SHP AT 10000 ft MSL
press <Shift-PrtSc> for hard copy, ENTER to continue

* POWER REFINEMENTS -- INSTALLATION LOSSES *

I.	- INLETS AND INLET DUCTING -			
	1. -S- TYPE (5%)			
	2. ICE SHIELD (10%)			
***	3. STRAIGHT-IN (2%)	INLET LOSSES =	77 SHP	2.0 %
II.	- ENGINE AIR PARTICLE SEPARATORS - EAPS			
	4. FOAM TYPE BARRIER FILTERS (10%)			
***	5. POWER (HYDRAULIC) SEPARATORS (2 - 6%)			
	6. NONE INSTALLED	EAPS LOSSES =	154 SHP	4.0 %
III.	- ENGINE EXHAUST DEVICES - EEDS			
	7. SIMPLE HEAT DIFFUSER (3%)			
	8. INFRA-RED SUPPRESSOR (5%)			
***	9. NONE INSTALLED	EEDS LOSSES =	0 SHP	0.0 %
	ENGINE, XMSN and MISC INSTALLATION LOSSES =		509 SHP	13.3 %
	TOTAL LOSSES (percent of ESHP) =		740 SHP	16.1 %
	MAXIMUM POWER REQUIRED [RSHP] =		3,839 SHP	
*	ENGINE SHAFT HORSEPOWER REQUIRED [ESHP] =		4,579 SHP	

press <Shift-PrtSc> for hard copy, ENTER to continue

```
                        * NUMBER OF ENGINES *                    (SECTION 6.1)
      1. NUMBER OF ENGINES =  2          (specified in Chapter 3)
                        * TYPE OF ENGINES *                      (SECTION 6.2)
      2. NUMBER OF ENGINES COMPETING FOR SELECTION ? 2
================================================================================
                    * ENGINE SELECTION PARAMETERS *
            ENGINE:              A          B
  3. DRY WEIGHT (lbs)..... 709        580
  4. SHP (ssl) military.... 1800       2500
  5. SFC (ssl) military.... .595       .615
  6. INITIAL COST..... $K  360        640
  7. OP COST/HR/ENG..... $  35        40
  8. PREV MAINT/HR/ENG.. $  125       160
  9.    MTBMA (hrs)..... 3            4
 10.    MDT (hrs)..... 1.3            2
 11.    MTBF (hrs)..... 285           280
 12.    MTBR (hrs)..... 800           1000

      13. SPECIFICATION AVERAGE FLIGHT HOURS PER YEAR ..... ? 120
      14. SPECIFICATION AVERAGE AIRFRAME SERVICE LIFE IN YEARS ? 9
      15. AVERAGE FLIGHT HOURS PER FLIGHT ..... ? .7

         press <Shift-PrtSc> for hard copy, ENTER to continue
```

* ENGINE SELECTION CRITERIA * (6.3 & 6.4)

	ENGINE A	B	C	D	E
POWERPLANT WEIGHT(installed)....	879	737			
LIFE-CYCLE COST .....K$	1066	1712			
ENGINE LIFE (hrs).....	800	1000			
No. OF REPLACEMENTS.....	0	0			
R/D COSTS.....K$	0	0			
INITIAL COSTS.....K$	360	640			
ANNUAL MAINT. COST.....K$	15	19			
ANNUAL OPERATING COST.....K$	4	5			
REPLACEMENT COST.....K$	486	864			
SALVAGE VALUE.....K$	288	512			
AVAILABILITY (per engine).....	0.698	0.667			
RELIABILITY (per engine).....	0.998	0.998			
MAINTAINABILITY (per engine)....	0.212	0.233			
PERFORMANCE (military SHP).....	1800	2500			

ENTER THE LETTER OF THE SELECTED ENGINE (i.e. A,B,C) a

press <Shift-PrtSc> for hard copy, ENTER to continue

```
  * TRANSMISSION SELECTION *  (6.5)

ENGINES:     TOTAL SHAFT HP =  4579.0 SHP
           NUMBER INSTALLED =     2
            INSTALLED WEIGHT =   879.2 lbs
TRANSMISSION: POWER RATING =  1900.0 SHP
                     WEIGHT =  1100.0 lbs
=========================================
        REVISED WEIGHT ESTIMATES

              A/C EMPTY WT  = 11561.7
                   FUEL WT  =  2600.0
              PERSONNEL WT  =  6250.0
               USEFUL LOAD  =  1800.0
-----------------------------------------
          GROSS WT ESTIMATE  = 22211.7 lbs
      TOTAL POWER FOR HOGE   =  1948.1 SHP
              DISK LOADING   =  5.5046 psf
           FIGURE OF MERIT   =  0.8142
```

```
  * REVISED COMPONENT WT  (6.6)

 1. MAIN ROTORS .........  2554.9
 2. FUSELAGE ............  2485.5
 3. LANDING GEAR ........   501.7
 4. ENGINE NACELLES .....   158.6
 5. ENGINES .............   772.5
 6. DRIVE TRAIN/XMSN ....  1163.7
 7. FUEL TANKS ..........   323.9
 8. FLIGHT CONTROLS .....   554.5
 9. AUX POWER (APU) .....   139.0
10. INSTRUMENTS .........   114.7
11. HYDRAULIC SYSTEM ....    58.5
12. ELECTRICAL SYSTEM ...   448.1
13. AVIONICS ............   445.0
14. FURNISHINGS .........   644.7
15. AC / DE-ICE EQUIP ...   125.1
16. LOAD HANDLING EQUIP..   149.2
-----------------------------------
REVISED COMPONENT WEIGHT = 11561.7
```

press <Shift-PrtSc> for hard copy, ENTER returns to MENU

	1. SFC (lb/hr/shp)	2. SHP	FUEL FLOW (lb/hr)
MILITARY:	.595	1800	2142.00
NORMAL:	.606	1530	1854.36
CRUISE:	.661	1148	1517.66

3. SPECIFICATION CONDITIONS: ALTITUDE = 4000 TEMP = 95

ZERO HP INTERCEPT = +418.35 (ssl) +373.64 (spec)

PHANTOM HORSEPOWER = +873.76 (ssl) +780.39 (spec)

* MAX RANGE *	* MAX ENDURANCE *
AIRSPEED = 120 kts	AIRSPEED = 70 kts
POWER = 2,183 SHP	POWER = 1,449 SHP
FUEL FLOW = 1,463 lb/hr	FUEL FLOW = 1,112 lb/hr

* CRUISE PWR & FUEL FLOW: 130 kts *	
(ssl)	(spec)
2,624 SHP	2,697 SHP
1,675 lb/hr	1,665 lb/hr

* TOTAL FUEL REQUIREMENTS *

4. SPEC MAX RANGE (NM) = 200

TOTAL FUEL REQUIRED = 2,954 lbs

DESIGN FUEL CAPACITY = 2,600 lbs

FUEL DEFICIENCY = 354 lbs

ANY CHANGES ? (0=NO,1=YES) 0

APPENDIX C

VARIABLE DEFINITIONS AND PROGRAM LISTING

1. Units and Constants

weight = pounds
airspeed = knots
velocity = feet per second
length = feet
angles = degrees
power = horsepower
fuelflow = pounds per hour
temperature = degrees Fahrenheit

PIE = 3.1415927
RHO = sea level density
MACH = mach number at sea level

2. Chapter Two Variables

MGW = specification maximum gross weight
GW = rough estimate gross weight
MTW = estimate of manufacturer's empty weight
VTIPMAX = maximum tip velocity
R = rotor radius
RPM = revolutions per minute
RV = rotational velocity in radians per second
CT = thrust coefficient
S = blade solidity
B = number of blades
C = main rotor blade chord
AR = main rotor blade aspect ratio
CL = average lift coefficient
CDO = blade drag coefficient
DL = disk loading
MU = advance ratio
MBL = maximum blade loading
VMAX = maximum forward velocity in feet per second
TASMX = maximum true airspeed in knots

3. Chapter Three Variables

TIPLOSS = main rotor blade tiploss
PI = induced power
PO = profile power
PP = parasite power
PT = total power
FM = figure of merit
PDW = percent difference in weight
FF = equivalent flat plate area
PEOPLE = number of people, including crew
PAX = weight of passengers and crew
SPECIAL = weight of special equipment
AV = vertical area presented by 2 rotors as seen from the front
AE = total main rotor blade area
W(N,N) = component weight
UL = useful load
FUEL = fuel weight in pounds
GEAR = type of landing gear
FHH = forward rotor height above the ground
VF = airspeed in feet per second
PI(I) = induced power in forward flight
PO(I) = profile power in forward flight

PP(I) = parasite power in forward flight
PT(I) = total power in forward flight
I = airspeed counter in knots
ENGN = number of engines installed

4. Chapter Four Variables

Blade optimization program to be added at a later date.

5. Chapter Five Variables

CLALFA = blade lift curve slope
TWIST = main rotor twist angle in degrees
T7 = main rotor twist angle in radians
AOAST = stall angle of attack for rotor blades in degrees
PASPEC = specification altitude
AE = effective disk area
VT = main rotor tip velocity
TAS(I) = airspeed in knots
MU = advance ratio
AOA90 = blade angle of attack at 90 degree position
AOA270 = blade angle of attack at 270 degree position
MACHVEL = local mach number as a function of altitude
MTIP = main rotor blade tip mach number
M90 = mach number advancing at 90 degree position
MCRT = main rotor blade critical mach number
DMD = difference between M90 and MCRT
MD = main rotor blade critical mach number for drag divergence
MTIPHVR = local tip mach number in hover
MTIPFLT = local tip mach number in forward flight
MXHVR = specification hover ceiling
CTHC = thrust coefficient at hover ceiling
TIPHC = tiploss at hover ceiling
PIHC = main rotor induced power at hover ceiling
B1 = tiploss
COLANGLE = collective angle in degrees
H8 = collective angle in radians
CYCLIC = cyclic angle in degrees
H2 = cyclic angle in radians
TASCR = cruise airspeed in knots, specification
TASMX = maximum airspeed in knots, specification
TASMAXP = airspeed for maximum power required
TASMINP = airspeed for minimum power required
PSPECHVR = total power to HIGE at hover ceiling
DELTA = pressure ratio
THETA = temperature ratio
RSHP = maximum rotor shaft horsepower required
INLET = inlet losses
PINLET = percent loss due to inlets
RSHPINLT = added horsepower for inlets
EAPS = losses due to engine air partical separators
PEAPS = percent loss due to EAPS
RSHPEAPS = added horsepower for EAPS
EEDS = losses due to engine exhaust diffusers
PEEDS = percent loss due to EEDS
RSHPEEDS = added horsepower with EEDS
ENGNLOST = horsepower required to operate engine devices
PCTENGN = percent power required for engine devices

MICSLOST - horsepower absorbed by engine, transmissions and accessories
PCTMISC - percent power required for engines, transmissions and accessories
RSHPLOST - total power lost between engines and rotors
PCTLOST - percent power lost between engines and rotors
ESHP - engine shaft horsepower required to provide rotor power

6. Chapter Six Variables

NENGSEL - number of engines competing for selection
MDT - maintenance down time
MTBF - mean time between failure
MTBR - mean time between replacement
DW(X) - engine dry weight
SHP (X) - engine shaft horsepower at military
SFC(X) - specific fuel consumption at military
ENG - number of engines
IC (X) - initial cost
OC (X) - operating cost per hour
PMA(X) - preventative maintenance per engine per hour
MTBMA(X) - mean time between maintenance action
AFL - average flight hours per year
SL - aircraft service life
TAV - average flight hour per flight
YM(X) - engine yearly maintenance cost
YO(X) - engine yearly operating cost
NRPL(x) - number of engine replacements
LC(X) - engine life-cycle cost
RD(X) - engine research and development costs
AVAIL(x) - engine availability
MAINT(x) - engine maintainability
RELY(x) - engine reliability
RC(X) - replacement costs
SV(X) - salvage costs
EWT(x) - installation engines weight
XMSNW - transmission weight
XMSNP - transmission power rating

7. Chapter Seven Variables

SFC(X) - specific fuel consumption
SHP - shaft horsepower
WDOTF(x) - fuel flow in pounds per hour
BETAH - slope of the fuel flow versus horsepower curve
ALPHAH - zero horsepower intercept
DELTA - pressure ratio
THETA - temperature ratio
ALT - specification altitude
TEMP - specification temperature
PF - phantom horsepower
TASMXR - maximum range velocity in knots
FFMXR - maximum range fuel flow
RHPMXR - maximum range referred horsepower
PTMXR - maximum range horsepower
TASMINP - maximum endurance velocity in knots
PTMIN - SHP for maximum endurance
RHPMXE - maximum endurance referred horsepower
FFMXE - maximum endurance fuel flow

TASCR = cruise velocity
PTCR = cruise power in horsepower
FFCR = cruise fuel flow
MXR = specification maximum range
TFUEL = total fuel required

8. Chapter Eight Variables

See program listing for variable definition.

9. Chapter Nine Variables

All variables are the same as above.

10. Chapter Ten Variables

C(X) = component cost
CE(X) = total cost
IFR = inflation rate
Q = quantity to be produced

```
1 'PROGRAM "TR1.BAS"
2 KEY OFF : FLG2=0
11
'*************************************************
14 '*        *** TANDEM ROTOR HELICOPTER DESIGN ***
15
'*************************************************
16 '
18 '                        *** ADMIN / CONTROL ***
20 '
21 PRINT"~L=TANDEM1/"
25 COLOR 1,1,1:PRINT"~C=ALL/":CLS: LOCATE 1,1,0
30 PRINT"~W=T_R_MENU/": INPUT" ",XX  : PRINT"~C=ALL/" :
CLS
35                  ON                        XX                    GOSUB
50,100,3000,4000,5000,6000,7000,8000,9000,9500,95
40 GOTO 25
50 LOCATE 1,1,0: PRINT"~W=INTRO/": INPUT" ",X1
55 PRINT"~C=ALL/" : RETURN 25
90 '
95 COLOR 1,1,1:LOCATE 1,1,0:PRINT"~W=R_U_SURE/"
96 INPUT"",ANS: IF ANS = 1 THEN 25 ELSE SYSTEM
97 '
98 '
100 '                    *** PRELIMINARY ROTOR DESIGN ***
110 '
120   COLOR    1,1,1:LOCATE    1,1,0:   PRINT"~C=ALL/":
PRINT"~W=PRELIM/": INPUT X2
125 COLOR 15,1 : PRINT"~C=ALL/"
130 CNT = 0
140  CLS:  LOCATE  1,27  :  PRINT  "* PRELIMINARY ROTOR
DESIGN *"
150 PRINT
160 PRINT "       1. DESIGN MAX GROSS WEIGHT [lbs] (2.1)
.....MGW = "
170 PRINT "                2. ESTIMATE  OF EMPTY WEIGHT [lbs]
(2.2).....MTW = "
180 PRINT "       3. ROTOR  TIP VELOCITY  (2.3; 700 fps
recommended) VT = "
190 PRINT "       4. DISC LOADING [lbs/ft^2] (2.4 ; FIG.
2-2)  ....DL = "
200  PRINT "                          ROTOR   RADIUS    [ft]
(2.4).....R = "
210  PRINT "                       ROTATIONAL VELOCITY [rpm]
.....RPM = "
220  PRINT  "                           THRUST  COEFFICIENT
(2.6).....CT = "
230 PRINT "       5. SPECIFICATION MAX AIRSPEED [knots]
(2.7)...TASMX = "
240  PRINT  "                         ADVANCE   RATIO  (2.7)
.....MU = "
250 PRINT "       6. MAX BLADE LOADING (2.7; FIG.2-3;
CT/S)....MBL = "
260  PRINT  "                       ROTOR   SOLIDITY  (2.7)
.....S = "
270 PRINT "       7. NUMBER OF ROTOR BLADES PER HEAD
(2.8)....B = "
280  PRINT "                       BLADE  CHORD  [ft] (2.9)
.....C = "
290  PRINT  "                          ASPECT  RATIO  (2.9)
.....AR = "
300  PRINT "                       AVG  LIFT  COEFF  (2.10)
.....CL = "
320 PRINT : COLOR 14,1
330 PRINT "       8. RETURN TO MAIN MENU."
340  LOCATE   23,6:  PRINT"***   FOR  HARD  COPY  PRESS
<Shift-PrtSc> BEFORE RETURNING TO MAIN MENU ***": COLOR
15,1
```

```
345 '
350 CNT = CNT + 1: J = 0
360   IF  CNT  =  1  THEN  370  ELSE  LOCATE 21,1: PRINT
SPC(77): GOTO 410
370   FOR J = 1 TO 7
380   LOCATE 21,20 : PRINT "ENTER  YOUR VALUE  FOR ITEM
NUMBER " ; J
390   X = J :GOTO 430
410   LOCATE 21,11:INPUT"WHICH PARAMETER DO YOU WISH TO
CHANGE / SELECT ? ",X
430   IF X < 1  OR  X > 8 THEN  GOSUB 1500  : IF  J = 0
THEN 410 ELSE 380
440   ON X GOSUB 510,520,530,540,550,560,570,25
450 IF CNT = 1 THEN NEXT J ELSE GOSUB 800
455 FLG1 = 1 : GOTO 350
460 '
480 '                          *** PRELIM ROTOR DESIGN INPUT
SUBROUTINES ***
500 '
510 LOCATE 3,61 : PRINT SPC(7) : LOCATE 3,60 :   INPUT"
",MGW
515 IF  MGW <=  0 THEN PRINT"~W=DVN0/" : GOTO 510  ELSE
RETURN
520 LOCATE 4,61 : PRINT SPC(7) : LOCATE 4,60 :   INPUT"
",MTW
525 IF  MTW <=  0 THEN PRINT"~W=DVN0/" : GOTO 520  ELSE
RETURN
530 LOCATE 5,61 : PRINT SPC(7) : LOCATE 5,60 :   INPUT"
",VT
535 IF  VT   <= 0 THEN PRINT"~W=DVN0/" : GOTO 530  ELSE
RETURN
540 LOCATE 6,61 : PRINT SPC(7) : LOCATE 6,60 :   INPUT"
",DL
545 IF   DL  <= 0 THEN PRINT"~W=DVN0/" : GOTO 540  ELSE
GOSUB 630 : RETURN
550 LOCATE 10,61: PRINT SPC(7) : LOCATE 10,60:   INPUT"
",TASMX
555 IF  TASMX <= 0 THEN PRINT"~W=DVN0/": GOTO 550  ELSE
GOSUB 690 : RETURN
560 LOCATE 12,61: PRINT SPC(7) : LOCATE 12,60:   INPUT"
",MBL
565 IF  MBL <=  0 THEN PRINT"~W=DVN0/" : GOTO 560  ELSE
GOSUB 710 : RETURN
570 LOCATE 14,61: PRINT SPC(7) : LOCATE 14,60:   INPUT"
",B
575 IF  B    <= 0 THEN PRINT"~W=DVN0/" : GOTO 570  ELSE
GOSUB 730 : RETURN
590 '
600 '       ***  PRELIMINARY ROTOR  DESIGN EQUATIONS AND
OUTPUT ***
610 '
630   PIE = 3.141592 : RHO0 = .0023769 : RHO = .0023769
636     R = SQR(ABS (.5 * MGW/(DL * PIE)))
640     RPM = VT * 9.55 / R
650     CT = MGW / (2 * RHO * PIE * R * R * VT * VT)
660 LOCATE  7,52 :  PRINT USING "####.####" ;  R
670 LOCATE  8,52 :  PRINT USING "####.####" ;  RPM
680 LOCATE   9,52  :    PRINT USING  "####.####" :  CT :
RETURN
690     MU = TASMX * 1.68893 / VT
700 LOCATE 11,52 :   PRINT  USING "####.####"  ;   MU :
RETURN
710 '*** solidity calcn ***
715     S = CT/MBL
720  LOCATE  13,52  :     PRINT USING "####.####" ;  S :
RETURN
730 '*** chord, aspect ratio, and lift coeff ***
735     C = S * PIE * R /B
```

```
740     AR = R/C
750     CL= CT * 6 / S
770 LOCATE 15, 52 :   PRINT USING "####.####" ;   C
780 LOCATE 16, 52 :   PRINT USING "####.####" ;   AR
790  LOCATE  17,  52  :     PRINT  USING  "####.####"   ;
CL:RETURN
800 '
820 '       *** PRELIMINARY ROTOR DESIGN SUBROUTINE  ***
840 '
850    R = SQR(ABS (.5 * MGW/(DL * PIE)))
860    RPM = VT * 9.55 / R
870    CT = .5 * MGW /(RHO * PIE * R * R * VT * VT)
880 LOCATE 7, 52 :   PRINT USING "####.####"; R
890 LOCATE 8, 52 :   PRINT USING "####.####"; RPM
900 LOCATE 9, 52 :   PRINT USING "####.####"; CT
910    MU = TASMX * 1.688 / VT
920 LOCATE 11, 52 : PRINT USING "####.####"; MU
935    S = CT/MBL
940 LOCATE 13, 52 : PRINT USING "####.####"; S
950    C = S * PIE * R /B
960    AR = R/C
970    CL= CT * 6 / S
980 LOCATE 15, 52 : PRINT USING"####.####"; C
990 LOCATE 16, 52 : PRINT USING"####.####"; AR
1000 LOCATE 17, 52: PRINT USING"####.####"; CL: RETURN
1500   LOCATE  1,1,0:   PRINT"~W=TRYAGAIN/": LOCATE 23,1:
PRINT SPC(77): RETURN
2000
3000     LOCATE    1,1,0:PRINT"~W=LOADNOTE/"     :FLG2=1:
CHAIN"TR3",,ALL
4000 LOCATE 1,1,0:PRINT"~W=BLDOPT/" :INPUT"",X4:GOTO 25
5000 LOCATE 1,1,0:PRINT"~W=LOADNOTE/"  :CHAIN"TR5",,ALL
6000 LOCATE 1,1,0:PRINT"~W=LOADNOTE/"  :CHAIN"TR6",,ALL
7000 LOCATE 1,1,0:PRINT"~W=LOADNOTE/"  :CHAIN"TR7",,ALL
8000 LOCATE 1,1,0:PRINT"~W=LOADNOTE/"  :CHAIN"TR8",,ALL
9000 LOCATE 1,1,0:PRINT"~W=LOADNOTE/"  :CHAIN"TR9",,ALL
9500 LOCATE 1,1,0:PRINT"~W=LOADNOTE/"  :CHAIN"TR10",,ALL
9999 END
1020 ' PROGRAM "TR3.BAS"...17 SEPT 87
1021
'*****************************************************-
*********
1022  '*     ***  TANDEM  ROTOR  SYSTEM  DESIGN & WEIGHT
ESTIMATION ***     *
1023
'*****************************************************-
*********
1024 'PLEASE NOTE: USING  BASICA  TO  RUN  THIS PROGRAM
WILL CAUSE  THE INPUT LINE TO BE DELETED IF THE FLASHUP
HELPWINDOW IS DISPLAYED !
1025                                                  DIM
W(20,20),GW(20),WE(20),W6(10),W6A(10),W6B(10),W6C(10),-
PDW(9)
1030 PIE = 3.141592 : RHO0 = .002377
1035 'MGW  = 23000:  R=25.5: C=1.5: CDO=.0089999:B = 3:
RPM = 267.4
1040 'S1= 34: GAP=  4:  FHH=  16:  PA=1:  TAS=1: FF=44:
AGL=10:
1045 A$="######.#" : B$="######" : C$="###.####"
1050    PRINT"~L=TANDEM3/"    :'FLG2   =   1:  FLG3  =  0
:'FLG2:flag fm TR1 rbf,FLG3
1060 KEY OFF : COLOR 15,1 : CLS: PRINT "~C=ALL/"
1090 '
1100    '*****************    POWER    VARIABLES    INPUT
************************
1150 '
1170 CNT = 1 : CLS: LOCATE 1,22
```

```
1180 PRINT  "* TANDEM  ROTOR SYSTEM  DESIGN *
(Alt-F1 for help)"
1190 PRINT
1200  PRINT  "                1.  DESIGN  MAX  GROSS WEIGHT
[lbs]..............MGW = "
1210  PRINT  "                                2.  ROTOR  RADIUS
[ft]..........................R = "
1220  PRINT  "                              3.  BLADE  CHORD  [ft]
.............................C = "
1230 PRINT  "              4. BLADE PROFILE DRAG COEFFICIENT
.....CDO = "
1240 PRINT  "          5. NUMBER  OF ROTOR  BLADES PER HEAD
.....B = "
1250  PRINT  "                        6.  OPERATING  RPM  [rpm]
.....................RPM = "
1260 PRINT  "                  7.  ROTOR  SHAFT  SPACING  [ft]
.........S1 = "
1270 PRINT  "          8. ROTOR HEAD VERTICAL SPACING  [ft]
.....GAP = "
1280 PRINT  "              9.  HEIGHT  OF  FORWARD  HEAD ABOVE
WHEELS [ft] ....FHH = "
1290  PRINT  "                    10. PRESSURE ALTITUDE  [ft  MSL]
.....PA = "
1300 PRINT  "                  11.  HOVER  ALTITUDE  [ft  AGL]
.....AGL = "
1310  PRINT  "                  12. TRUE AIRSPEED [knots] (0 FOR
HOVER).....TAS = "
1320 PRINT  "              13.  EQUIVALENT FRONTAL  AREA  [ft^2]
.....FF = "
1325 COLOR 14,1
1330 PRINT  "              14. COMPONENT WEIGHT ESTIMATES  15.
RETURN TO MAIN MENU"
1331 COLOR 15,1
1332 IF FLG2 = 1 THEN 1335 ELSE 1375
1335 'load data from  previous chapter,  if applicable;
or allows input'
1336 '
1338 IF  MGW <>0 THEN LOCATE  3,61: PRINT USING A$; MGW
ELSE GOSUB 1500
1340 IF R   <>0 THEN LOCATE  4,61:  PRINT USING  A$; R
ELSE GOSUB 1520
1342 IF  C     <>0 THEN LOCATE  5,61: PRINT USING A$; C
ELSE GOSUB 1540
1344 IF CDO <>0 THEN LOCATE  6,61: PRINT USING  C$; CDO
ELSE GOSUB 1560
1346 IF  B     <>0 THEN LOCATE  7,61: PRINT USING B$; B
ELSE GOSUB 1580
1348 IF RPM <>0 THEN LOCATE  8,61: PRINT USING  A$; RPM
ELSE GOSUB 1600
1350 IF  S1    <>0 THEN LOCATE  9,61: PRINT USING A$; S1
ELSE GOSUB 1620
1352 IF GAP <>0 THEN LOCATE 10,61: PRINT  USING A$; GAP
ELSE GOSUB 1640
1354 IF  FHH <>0 THEN LOCATE 11,61: PRINT USING A$; FHH
ELSE GOSUB 1660
1356 IF PA  =>0 THEN LOCATE 12,61:  PRINT USING  B$; PA
ELSE GOSUB 1680
1358 IF  AGL <>0 THEN LOCATE 13,61: PRINT USING B$; AGL
ELSE GOSUB 1700
1360 IF TAS =>0 THEN LOCATE 14,61: PRINT  USING B$; TAS
ELSE GOSUB 1720
1362 IF  FF    <>0 THEN LOCATE 15,61: PRINT USING A$; FF
ELSE GOSUB 1740
1364 GOSUB 1770 : GOSUB 2140
1366 '
1370 CNT = CNT + 1: J = 0
1375 IF CNT =  1  THEN  1380  ELSE  LOCATE  23,1: PRINT
SPC(77): GOTO 1420
```

```
1380    FOR J = 1 TO 13
1390     LOCATE  23,20:PRINT "ENTER  YOUR VALUE FOR ITEM
NUMBER " ; J
1400     X = J  : GOTO 1440
1420    LOCATE  23,11:INPUT"WHICH PARAMETER  DO YOU WISH
TO SELECT / CHANGE " ;X
1440     IF  X <  1 OR  X > 15 THEN GOSUB 4500: IF J = 0
THEN 1420 ELSE 1390
1450     ON  X GOSUB 1500,1520,1540,1560,1580,1600,1620,
1640,1660,1680,1700,1720,1740,2250,9000
1460 IF CNT = 1 THEN NEXT J
1470 FLG2 = 1 : GOTO 1370
1480     '*****************          DATA   ENTRY  SUBROUTINES
**************************
1490 '
1500 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW1/"
1505 LOCATE 3,61:PRINT SPC(8):LOCATE 3,60:INPUT" ",MGW:
PRINT"~K=(ALT-F1)/"
1510 IF MGW <=0 THEN PRINT"~W=DVN0/": GOTO 1500
1515 IF  CNT>1 THEN GOSUB 1770:GOSUB 2140: RETURN  ELSE
RETURN
1520 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW2/"
1522 LOCATE 4,61: PRINT SPC(8): LOCATE  4,60:INPUT" ",R
: PRINT"~K=(ALT-F1)/"
1524 IF R  <= 0 THEN PRINT"~W=DVN0/": GOTO 1520  ELSE
1526 IF  CNT>1 THEN GOSUB 1770:GOSUB 2140: RETURN  ELSE
RETURN
1540 LOCATE 1,1,0:  PRINT"~K=(ALT-F1),HW3/"
1542 LOCATE 5,61:PRINT SPC(8):LOCATE  5,60:INPUT" ",C :
PRINT"~K=(ALT-F1)/"
1544 IF C <= 0 THEN PRINT"~W=DVN0/": GOTO 1540 ELSE
1546 IF  CNT>1 THEN GOSUB 1770:GOSUB 2140: RETURN  ELSE
RETURN
1560 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW4/"
1565  LOCATE  6,61:PRINT  SPC(8):LOCATE  6,60:  INPUT"
",CDO:PRINT"~K=(ALT-F1)/"
1570 IF CDO <= 0 THEN PRINT"~W=DVN0/": GOTO 1560 ELSE
1575 IF  CNT>1 THEN GOSUB 1770:GOSUB 2140: RETURN  ELSE
RETURN
1580 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW5/"
1585 LOCATE 7,61:PRINT SPC(8):LOCATE  7,60: INPUT" ",B:
PRINT"~K=(ALT-F1)/"
1590 IF B  <= 0 THEN PRINT"~W=DVN0/": GOTO 1580 ELSE
1595 IF  CNT>1 THEN GOSUB 1770:GOSUB 2140: RETURN  ELSE
RETURN
1600 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW6/"
1610 LOCATE 8,61:PRINT SPC(8):LOCATE 8,60: INPUT" ",RPM
:PRINT"~K=(ALT-F1)/"
1615 IF RPM <= 0 THEN PRINT"~W=DVN0/": GOTO 1600 ELSE
1618 IF  CNT>1 THEN GOSUB 1770:GOSUB 2140: RETURN  ELSE
RETURN
1620 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW7/"
1630 LOCATE 9,61: PRINT SPC(8):LOCATE 9,60: INPUT" ",S1
1635 PRINT"~K=(ALT-F1)/":IF CNT>1 THEN GOSUB 1770:GOSUB
2140: RETURN ELSE RETURN
1640 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW8/"
1650  LOCATE  10,61:  PRINT  SPC(8):LOCATE 10,60:INPUT"
",GAP
1655  PRINT"~K=(ALT-F1)/"  :  IF  CNT>1  THEN  GOSUB
1770:GOSUB 2140: RETURN ELSE RETURN
1660 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW9/"
1665  LOCATE  11,61:PRINT  SPC(8):LOCATE  11,60:INPUT"
",FHH: PRINT"~K=(ALT-F1)/"
1670 IF FHH <= 0 THEN PRINT"~W=DVN0/": GOTO 1660 ELSE
1675 IF CNT>1 THEN GOSUB 1770:GOSUB 2140 :  RETURN ELSE
RETURN
1680 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW10/"
```

```
1685  LOCATE  12,61:PRINT  SPC(8):LOCATE  12,60: INPUT"
",PA
1690   PRINT"~K=(ALT-F1)/"   :    IF    CNT>1    THEN  GOSUB
1770:GOSUB 2140:  RETURN  ELSE RETURN
1700  LOCATE 1,1,0:  PRINT"~K=(ALT-F1),HW11/"
1710   LOCATE  13,61:PRINT  SPC(8):LOCATE  13,60: INPUT"
",ACL
1715   PRINT"~K=(ALT-F1)/"   :    IF    CNT>1    THEN  GOSUB
1770:GOSUB 2140:  RETURN  ELSE RETURN
1720  LOCATE 1,1,0:  PRINT"~K=(ALT-F1),HW12/"
1730   LOCATE  14,61:PRINT  SPC(8):LOCATE  14,60: INPUT"
",TAS
1735   PRINT"~K=(ALT-F1)/"   :    IF    CNT>1    THEN  GOSUB
1770:GOSUB 2140:  RETURN  ELSE RETURN
1740  LOCATE 1,1,0:  PRINT"~K=(ALT-F1),HW13/"
1750   LOCATE  15,61:PRINT  SPC(8):LOCATE  15,60: INPUT"
",FF:  PRINT"~K=(ALT-F1)/"
1755  IF FF <=   0   THEN   PRINT"~W=DVN0/":GOTO   1740  ELSE
GOSUB 1770
1760  GOSUB 2140: RETURN :'1460
1765  '
1770    '**********************    POWER    COMPUTATION    SUBR
**********************
1780  N = 1 :GW(1) = MGW : 'subr access from line 1755
1790  '
1800  'N = 1 thru 5 as sent from weight comp admin subr.
1820  GW(1) = .8 * MGW
1830  CNT =CNT + 1
1840  RTRHT = FHH + .5 * GAP
1850  GE = (ACL+RTRHT) / (2*R)
1860  PGE =  .5147 + 1.3432*GE - 1.457*GE^2 + .708*GE^3 -
.1276*GE^4
1870  RV    =   RPM/9.55     :    VT = RV * R   :   VF = TAS *
1.68893
1880  SIGMA = (1 - 6.87535E-06 * PA)^4.2561
1890   IF   PA=0   THEN   RHO=RHO0   ELSE   IF   PA=4000   THEN
RHO=.001918 ELSE RHO=SIGMA*RHO0 :'lb-sec^2/ft^4
1900  MU = VF / VT
1910  T = 1.055 * GW(N)
1920  S = B * C /(PIE * R)
1930  TIPLOSS = 1 - ( SQR(2 * CT) / B)
1940  RE = R * TIPLOSS
1950  SR = S1 / R
1960    AE=   2*RE^2*(PIE-(PIE/180)*ACOS(S1/(2*RE)))    +
S1*SQR(RE^2-(S1^2)/4)
1965  CT = T / ( RHO * AE * VT^2 )
1970  K = 1.46 - .253 * SR
1980  AV = PIE * R^2 - 2 * R * GAP
1990  VI = SQR(T/(2*RHO*AE))
2000    KU      =    SQR(SQR(1+.25*((AV/AE)*(VF/VI))^4)    -
.5*((AV/AE)*(VF/VI))^2)
2004  DL = GW(N) / AE
2006  CL = 6 * CT/S
2007  AR = R/C
2008  BL = CT / S
2009  IF  B*C*R/S1 > 3.75 THEN COLOR 1,1,1:LOCATE 1,1,0:
PRINT"~W=BLDSTRK/":INPUT X4 :PRINT"~C=ALL/": COLOR 15,1
2020  '
2030  '                          *** POWER CALCULATION  ***
2040  '
2060  IF GE <= 2 THEN PI = PGE * T *  VI *  K *  KU /550
ELSE
2070  PI = T * VI * K * KU / 550
2080  PO = (CDO * B * C * R * VT^3 * RHO / 2200)*(1+ 4.3
* MU^2)
2090  PP = VF^3 * FF * RHO / 1100
2100  PC = (T * VV + RHO * FF * VV^3 ) / 1100
2105  FM = PI / (PI + PO)
```

```
2110 PT = PI + PO + PP + PC
2120 RETURN
2130 '
2140 '  ********************* POWER  RESULTS OUTPUT SUBR
**********************
2150 '
2170 LOCATE 17,34:PRINT "-- RESULTS --"
2180 LOCATE 18,14:PRINT USING"PI = #####.##"; PI
2190 LOCATE 19,14:PRINT USING"PO = #####.##"; PO
2200 LOCATE 20,14:PRINT USING"PP = #####.##"; PP
2210 'LOCATE 21,14:PRINT USING"PC = #####.##"; PC
2220 LOCATE 22,14:PRINT USING"PT = #####.##"; PT:LOCATE
22,29: PRINT "HP"
2230 LOCATE  18,46:PRINT USING"FM   = ###.##"; FM:LOCATE
18,59:PRINT"( .75 to.85) *HOVER
2232 LOCATE  19,46:PRINT USING"DL   = ###.##"; DL:LOCATE
19,59:PRINT"(  5 to 15 )  ONLY
2234 LOCATE  20,46:PRINT USING"CL   = ###.##"; CL:LOCATE
20,59:PRINT"(CLmax; 1.55)
2236 LOCATE  21,46:PRINT USING"AR   = ###.##"; AR:LOCATE
21,59:PRINT"( 15 to 20 )
2238 LOCATE  22,46:PRINT USING"BL   = ##.###"; BL:LOCATE
22,59;PRINT"(BLmax; 0.12)
2239
2240 RETURN :'returns to 1366 or 1460
2249 '
2250 '***************  COMPONENT WEIGHT APROX INPUT SUBR
***************
2251 '
2252  'FLG3=1:  GEAR=1:  ENGN=1:  FUEL=2500: PEOPLE=25:
SPECIAL=100: UL=1000:'remove before flight
2253 CLS:PRINT"~C=ALL/":LOCATE 1,1,0:PRINT"~W=WT_EST/":
INPUT" ",X3: PRINT"~C=ALL/":CLS
2255  LOCATE  1,22:  PRINT"*  COMPONENT  WEIGHT
APPROXIMATIONS *  (Alt-F1 for help)"
2260 PRINT"~K=(ALT-F1),WTAPRXHW/"
2265 IF FLG3 =1 THEN 2360 ELSE
2270  '*****************  SUPPLEMENTARY  DATA  INPUT
**********************
2271 '
2272 LOCATE  3,2:  PRINT"1.  TYPE  LNDG  GEAR (TRICYCLE
STYLE)"
2276 LOCATE  4,2: INPUT"       1=FIXED  2=RETRACTABLE
....  ",GEAR
2280 LOCATE 5,2: INPUT"2. NUMBER OF ENGINES (2 or more)
... ",ENGN
2285  LOCATE  6,2:  INPUT"3.  ESTIMATED  FUEL  CAPACITY
(lbs)....  ",FUEL
2290 LOCATE 7,2: INPUT"4. NUMBER OF CREW AND PASSENGERS
",PEOPLE
2292 LOCATE  8,2: INPUT"5. WT OF SPECIAL AVIONICS (lbs)
.... ",SPECIAL
2294 LOCATE  9,2:  INPUT"6.  SPECIFICATION  USEFUL LOAD
(lbs)  ",UL
2295 GOSUB 3000
2296 COLOR  14,1:LOCATE 10,2: PRINT"7. RETURN TO TANDEM
ROTOR SYSTEM DESIGN"
2298 LOCATE 12,2: PRINT SPC(40) : FLG3 = 1
2300 LOCATE 12,2: INPUT"  SELECTION  ?  (1  thru  6 for
changes)  ",X:COLOR 15,1
2307 IF X = 7 THEN PRINT"~K=(ALT-F1)/"
2310 IF X < 1 OR X > 7 THEN BEEP: GOTO 2296 ELSE
2315  ON  X  GOSUB  2320,2325,2330,2335,2340,2345,1100:
GOSUB 3000: GOTO 2296
2320  LOCATE  4,39:  PRINT  SPC(6):  LOCATE 4,38:INPUT"
",GEAR :RETURN
2325  LOCATE  5,39:  PRINT  SPC(6):  LOCATE 5,38:INPUT"
",ENGN :RETURN
```

```
2330  LOCATE  6,39:  PRINT  SPC(6):  LOCATE 6,38:INPUT"
",FUEL :RETURN
2335  LOCATE  7,39:  PRINT  SPC(6):  LOCATE 7,38:INPUT"
",PEOPLE :RETURN
2340  LOCATE  8,39:  PRINT  SPC(6):  LOCATE 8,38:INPUT"
",SPECIAL :RETURN
2345 LOCATE 9,39: PRINT SPC(6): LOCATE 9,38:INPUT" ",UL
:RETURN
2350 '
2360 '*** routine to  list these  parameters first with
option to change.
2363  LOCATE  3,2:  PRINT"1.  TYPE  LNDG GEAR (TRICYCLE
STYLE)"
2365  LOCATE  4,2:  PRINT  USING"                1=FIXED
2=RETRACTABLE ..... #####";GEAR
2370 LOCATE 5,2: PRINT USING"2. NUMBER OF ENGINES (2 or
more) ... #####";ENGN
2375 LOCATE 6,2: PRINT USING"3. ESTIMATED FUEL CAPACITY
(lbs)... #####";FUEL
2380  LOCATE  7,2:  PRINT  USING"4.  NUMBER OF CREW AND
PASSENGERS ... #####";PEOPLE
2385 LOCATE 8,2: PRINT USING"5. WT  OF SPECIAL AVIONICS
(lbs) .... #####";SPECIAL
2390  LOCATE  9,2:  PRINT USING"6. SPECIFICATION USEFUL
LOAD (lbs).. #####";UL
2400 GOSUB 3000: GOTO 2296
2410 '
2465  '  ***********  COMP  WT  RESULTS  OUTPUT  SUBR
**************************
2466 '
2469 LOCATE 3,53 : PRINT"* COMPONENT *      * WEIGHT "
2470  LOCATE  4,47  :  PRINT  USING"  1.  MAIN
ROTORS..... #####.#"; W(1,NN)
2475  LOCATE  5,47  :  PRINT  USING"  2.
FUSELAGE..... #####.#"; W(3,NN)
2480  LOCATE  6,47  :  PRINT  USING"  3.  LANDING  GEAR
..... #####.#"; W(4,NN)
2485  LOCATE  7,47  :  PRINT  USING"  4.  ENGINE
NACELLES..... #####.#"; W(5,NN)
2490  LOCATE  8,47  :  PRINT  USING"  5.
ENGINES..... #####.#"; W6A(NN)
2495  LOCATE  9,47  :  PRINT  USING"  6.  DRIVE
TRAIN..... #####.#"; W6B(NN)
2500  LOCATE  10,47:  PRINT  USING"  7.  FUEL  TANKS
..... #####.#"; W6C(NN)
2503 W(6,NN) = W6A(NN) + W6B(NN) + W6C(NN)
2505  LOCATE  11,47:  PRINT  USING"  8.  FLIGHT
CONTROLS..... #####.#"; W(7,NN)
2510  LOCATE  12,47:  PRINT  USING"  9.  AUX  POWER
(APU)..... #####.#"; W(8,NN)
2515  LOCATE  13,47:  PRINT  USING"10.
INSTRUMENTS..... #####.#"; W(9,NN)
2520  LOCATE  14,47:  PRINT  USING"11.  HYDRAULIC
SYSTEM..... #####.#"; W(10,NN)
2525  LOCATE  15,47:  PRINT  USING"12.  ELECTRICAL
SYSTEM.... #####.#"; W(11,NN)
2530  LOCATE  16,47:  PRINT  USING"13.
AVIONICS..... #####.#"; W(12,NN)
2535  LOCATE  17,47:  PRINT  USING"14.
FURNISHINGS..... #####.#"; W(13,NN)
2540  LOCATE  18,47:  PRINT  USING"15.  AC  /  DE-ICE
EQUIP.... #####.#"; W(14,NN)
2545  LOCATE  19,47:  PRINT  USING"16.  LOAD  HANDLING
EQUIP.. #####.#"; W(15,NN)
2550  LOCATE  20,47:
PRINT"-----------------------------------"
2555 LOCATE 21,47: PRINT USING" TOTAL  COMPONENT WEIGHT
= #####.#"; WE(NN)
```

```
2560                          LOCATE                              13,2:
PRINT"=========================================="
2565 LOCATE 14,5: PRINT USING"SPEC MAX GROSS WT (MGW)
= #####.# lbs";MGW
2570 LOCATE 15,5: PRINT USING"       NEW A/C EMPTY WT
= #####.#";WE(NN)
2574 LOCATE 16,5: PRINT USING"                FUEL WT
= #####.#";FUEL
2580 LOCATE 17,5: PRINT USING"           PERSONNEL WT
= #####.#";PAX
2582 LOCATE 18,5: PRINT USING"            USEFUL LOAD
= #####.#";UL
2585                          LOCATE                              19,2:
PRINT"------------------------------------------"
2587 LOCATE 20,5: PRINT USING"  NEW GROSS WT ESTIMATE
= #####.# lbs";NGWE(NN)
2590 LOCATE 21,5: PRINT USING" TOTAL POWER FOR HOVER
= #####.# SHP";PT
2600 LOCATE 23,22: PRINT "* press <Shift-PrtSc> for
hard copy *
2620 FLG3=1 : RETURN
2999 '
3000 '*****************  WEIGHT  COMPUTATION  SUBR
*************************
3001 '
3005 N = 0 : PRINT"~W=COMP/"
3010 FOR N = 1 TO 5
3020                IF  MTW<>0  THEN  WE(1)=MTW  ELSE
WE(1)=.7407*MGW-2500
3040      GOSUB 1800  :'computes PT,PI and PO based on
GW(N)
3050    HP = PT
3060    GOSUB 4000  : '  computes new GW est based on
previous GW and HP
3070 NEXT N
3100 NN = 0 : PDW(0) = 10
3110 N = 0 : FOR N = 1 TO 5
3120    IF PDW(N) < 10 THEN 3130 ELSE 3140
3130    IF PDW(N) < PDW(N-1) THEN NN = N ELSE
3140 NEXT N
3150 IF NN = 0 THEN LOCATE 1,1,0: PRINT"~W=NOTCONVG/":
INPUT" ",X3: NN = 1
3160 '
3200 PRINT"~C=ALL/" : GOSUB 2465 : RETURN  :'output
results
3990 '
4000 '  ****************  HELO COMPONENT WT EQN'S SUBR
************************
4010 '
4020   PAX = PEOPLE * 250
4030   SB = 567.688 * EXP(.000041 * GW(N))
4050 W(1,N) = 1414.348 * EXP(.00539*B*C*R)  :  W(2,N) =
0
4060 W(3,N) = 3467.29 * LOG(SB) - 22118.3
4070 W(4,N) = .4013 * GW(N)^.6662 * GEAR * 3^.536
4080 W(5,N) = .014 * (.2014 * GW(N))^1.136
4090 W6A(N) = 565.507 * EXP(.000198 * HP)
4100 W6B(N) = .999 * (HP)^.959
4110  W6C(N)  =  454.619*(FUEL /6.5)^-.0566 : W(6,N) =
W6A(N)+W6B(N)+W6C(N)
4120 W(7,N) = .00334 * (GW(N))^1.224
4130 W(8,N) = 139!
4140 W(9,N) = 68.226 * LOG(HP) - 387.598
4150 W(10,N) = 6.63E-07 * (GW(N))^1.863
4160 W(11,N) = 9.78 * (SB)^.539
4170 W(12,N) = 325 + SPECIAL
4175 W(13,N) = .159 * SB +18.11 * PEOPLE
4180 W(14,N) = 117.771 * LOG(SB) -710.594
```

```
4190 W(15,N) = .111 * SB + 3.49 * PEOPLE - 72
4200 I=0:WE(N)=0:FOR  I=1 TO 15:WE(N)=W(I,N)+WE(N):NEXT
I:'weight summation
4210 GW(N+1) = WE(N) + UL + PAX + FUEL
4215 NGWE(N) = WE(N) + UL + PAX + FUEL
4220 PDW(N) = 100*ABS(1 - (GW(N+1)/GW(N)))
4300 RETURN
4500  LOCATE  1,1,0:  PRINT"~W=TRYAGAIN/": LOCATE 23,1:
PRINT SPC(77): RETURN
9000      CLS:      GW=MGW:      FLG2=1:PRINT"~C=ALL/":
PRINT"~W=LOADNOTE/": CHAIN"TR1",,ALL
9999 END
10  '  PROGRAM "TR5.BAS"...17 SEPT 87
20
'*************************************************************
30 '***  POWER REFINEMENTS PROGRAM w/HIGH SPEED EFFECTS
***
40
'*************************************************************
44                                                        DIM
TAS(300),PI(300),PO(300),PP(300),PT(300),PS(300), PM(3-
00)
50   KEY   OFF   :   A$="######.#"   :   B$="######"   :
C$="###.####"
51  IF ENGN=0 THEN ENGN=2
52  '  GW = 23000 : R= 25.5 : C= 1.5 : CDO= 8.999999E-03
:   B=   3   :   RPM   =   267.4:   S1=34:   GAP=4:   FHH=12:
PASPEC=4000:   FF=44:   AGL=10:   FLG3=1:   MXHVR=10000
:CLALFA=5.73: AOAST=14: TWIST=-9.5: MCRT=.8
58  ' TASCR = 130: TASMX = 150
70 COLOR 15,1 :PRINT"~L=TANDEM3/" :  PRINT "~C=ALL/"
90 '                        ***  INPUT VARIABLES  ***
100 CLS: CNT = 0
120 LOCATE 1,12: PRINT"*  HIGH SPEED  EFFECTS AND POWER
SUMMARY *  (Alt-F1 for HELP)"
130 PRINT
140  PRINT   "                    1.  GROSS  WEIGHT    [lbs]
.....GW = "
150   PRINT  "                              2.   ROTOR   RADIUS
[ft].....R = "
160  PRINT  "                3.  BLADE  DATA:   CHORD  [ft]
.....C = "
170 PRINT "          4.                PROFILE  DRAG COEFFICIENT
.....CDO = "
180 PRINT "          5.              LIFT CURVE SLOPE [per RAD]
.....CLALFA = "
190 PRINT "          6.            STALL ANGLE OF  ATTACK  [deg]
.....AOAST = "
200 PRINT  "              7.            GEOMETRIC TWIST [deg with
sign].....TWIST = "
210 PRINT "                8.                  CRITICAL  MACH NUMBER
.....MCRT = "
220 PRINT  "            9. NUMBER OF ROTOR BLADES PER HEAD
.....B = "
230  PRINT  "                  10.   OPERATING  RPM      [rpm]
.....RPM = "
240  PRINT  "              11.  ROTOR  SHAFT  SPACING   [ft]
.....S1 = "
250 PRINT "        12. ROTOR HEAD  VERTICAL SPACING   [ft]
.....GAP = "
260 PRINT "        13. HEIGHT OF FORWARD HEAD ABOVE WHEELS
[ft].....FHH = "
270 PRINT "        14. SPEC PRESSURE ALT [normally 4000 ft
MSL]..PASPEC = "
280  PRINT  "                15.  HOVER  ALTITUDE   [ft  AGL]
.....AGL = "
290 PRINT "          16.  SPEC  CRUISE  AIRSPEED   [knots]
.....TASCR = "
```

```
300  PRINT  "          17.  SPEC  MAX  AIRSPEED [knots]
.....TASMX = "
310 PRINT "          18.  EQUIVALENT FRONTAL  AREA  [ft^2]
.....FF = "
320 PRINT "          19. SPEC MAX HOVER ALTITUDE (IGE) [ft]
.....MXHVR = "
325 COLOR 14,1
330 PRINT "          20.  COMPUTE NEW  POWER REQUIREMENTS
21. RETURN TO MAIN MENU"
335 COLOR 15,1
340 IF FLG3 = 1 THEN 350 ELSE 560
350 'load data from previous chapter, if applicable; or
allows input!
370 IF GW    <>0 THEN LOCATE  3,61: PRINT  USING A$; GW
 ELSE GOSUB 710
380 IF  R    <>0 THEN LOCATE  4,61: PRINT USING A$; R
 ELSE GOSUB 750
390 IF C     <>0 THEN LOCATE  5,61: PRINT USING  A$; C
 ELSE GOSUB 790
400 IF CDO   <>0 THEN LOCATE  6,61: PRINT USING C$; CDO
ELSE GOSUB 830
410  IF  CLALFA<>0  THEN  LOCATE   7,61:  PRINT  USING
A$;CLALFA ELSE GOSUB 870
420  IF  AOAST  <>0  THEN  LOCATE   8,61:  PRINT USING
A$;AOAST  ELSE GOSUB 910
430  IF  TWIST  <>0  THEN  LOCATE   9,61:  PRINT USING
A$;TWIST ELSE GOSUB 950
440 IF MCRT  <>0 THEN LOCATE 10,61: PRINT USING A$;MCRT
ELSE GOSUB 980
450 IF B     <>0 THEN LOCATE 11,61: PRINT USING B$;B
 ELSE GOSUB 1010
460 IF  RPM   <>0 THEN LOCATE 12,61: PRINT USING A$;RPM
 ELSE GOSUB 1180
470 IF S1    <>0 THEN LOCATE 13,61: PRINT USING  A$;S1
 ELSE GOSUB 1080
480 IF  GAP   <>0 THEN LOCATE 14,61: PRINT USING A$;GAP
 ELSE GOSUB 1110
490 IF FHH   <>0 THEN LOCATE 15,61: PRINT  USING A$;FHH
 ELSE GOSUB 1140
500  IF   PASPEC<>0  THEN  LOCATE  16,61:  PRINT  USING
B$;PASPEC ELSE GOSUB 1180
510 IF AGL   <>0 THEN LOCATE 17,61: PRINT  USING B$;AGL
 ELSE GOSUB 119
520  IF  TASCR  <>0  THEN  LOCATE  18,61:  PRINT  USING
B$;TASCR ELSE GOSUB 1200
530  IF  TASMX  <>0  THEN  LOCATE  19,61:  PRINT  USING
B$;TASMX ELSE GOSUB 1210
540 IF  FF    <>0 THEN LOCATE 20,61: PRINT USING A$;FF
 ELSE GOSUB 1220
545  IF  MXHVR  <>0  THEN  LOCATE  21,61:  PRINT  USING
B$;MXHVR ELSE GOSUB 1225
550 CNT = 1: J = 0
560 IF CNT = 0 THEN 570 ELSE LOCATE 23,1:PRINT SPC(77):
GOTO 610
570 FOR J = 1 TO 19
580   LOCATE 23,20:PRINT  "ENTER  YOUR  VALUE  FOR ITEM
NUMBER " ;J
590     X = J :   GOTO 630
610     LOCATE 23,18:INPUT"WHICH DO YOU WISH TO CHANGE /
SELECT " ;X
630   IF X < 1 OR  X >  21 THEN  GOSUB 4500:  IF J  = 0
THEN 610 ELSE 580
640         ON   X  GOSUB  710,750,790,830,870,910,950,980,
1010,1050,1080,1110,1140,1180,1190,1200,1210,1220,1225,
1230,9000
650 IF CNT = 0 THEN NEXT J ELSE 550
660 GOTO 550
670 '
```

```
680 '                    ***  DATA ENTRY SUBROUTINES  ***
710 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW1/": LOCATE 3,61:
PRINT    SPC(8):     LOCATE    3,60:INPUT"    ",GW    :
PRINT"~K=(ALT-F1)/" : IF GW <=0 THEN  PRINT"~W=DVN0/" :
GOTO 710 ELSE RETURN
750 LOCATE 1,1,0:PRINT"~K=(ALT-F1),HW2/" : LOCATE 4,61:
PRINT    SPC(8):     LOCATE    4,60:INPUT"    ",R     :
PRINT"~K=(ALT-F1)/"  : IF R <= 0 THEN PRINT"~W=DVN0/" :
GOTO 750 ELSE RETURN
790 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW3/": LOCATE 5,61:
PRINT    SPC(8):     LOCATE    5,60:INPUT"    ",C     :
PRINT"~K=(ALT-F1)/"  : IF C <= 0 THEN PRINT"~W=DVN0/" :
GOTO 790 ELSE RETURN
830 LOCATE 1,1,0: PRINT"~K=(ALT-F1),HW4/": LOCATE 6,61:
PRINT          SPC(8):          LOCATE          6,60:INPUT"
",CDO:PRINT"~K=(ALT-F1)/"
850   IF CDO  <= 0 THEN PRINT"~W=DVN0/" : GOTO 830 ELSE
RETURN
870 LOCATE  1,1,0:   PRINT"~K=(ALT-F1),CLALPHA/": LOCATE
7,61:PRINT SPC(8)
880   LOCATE  7,60:INPUT" ",CLALFA: PRINT"~K=(ALT-F1)/"
890    IF CLALFA  <= 0  THEN PRINT"~W=DVN0/"  : GOTO 870
ELSE  RETURN
910 LOCATE  1,1,0: PRINT"~K=(ALT-F1),STALLAOA/": LOCATE
8,61:PRINT SPC(8)
920   LOCATE  8,60:INPUT" ",AOAST : PRINT"~K=(ALT-F1)/"
930   IF AOAST <= 0 THEN PRINT"~W=DVN0/" : GOTO 910 ELSE
RETURN
950 LOCATE  1,1,0: PRINT"~K=(ALT-F1),BLDTWIST/": LOCATE
9,61:PRINT SPC(8)
960    LOCATE  9,60:INPUT" ",TWIST : PRINT"~K=(ALT-F1)/"
: RETURN
980   LOCATE  1,1,0:   PRINT"~K=(ALT-F1),MCRIT/":  LOCATE
10,61:PRINT SPC(8)
990   LOCATE 10,60:INPUT" ",MCRT : PRINT"~K=(ALT-F1)/"
1000   IF MCRT <= 0 THEN PRINT"~W=DVN0/" : GOTO 980 ELSE
RETURN
1010   LOCATE   1,1,0:   PRINT"~K=(ALT-F1),HW5/":  LOCATE
11,61:PRINT SPC(8)
1020   LOCATE 11,60:INPUT" ",B      : PRINT"~K=(ALT-F1)/"
1030    IF B        <= 0 THEN PRINT"~W=DVN0/" : GOTO 1010
ELSE RETURN
1050   LOCATE   1,1,0:   PRINT"~K=(ALT-F1),HW6/":  LOCATE
12,61:PRINT SPC(8)
1060   LOCATE 12,60:INPUT" ",RPM    : PRINT"~K=(ALT-F1)/"
1070   IF RPM <= 0 THEN PRINT"~W=DVN0/" : GOTO 1050 ELSE
RETURN
1080   LOCATE   1,1,0:   PRINT"~K=(ALT-F1),HW7/":  LOCATE
13,61:PRINT SPC(8)
1090   LOCATE 13,60:INPUT" ",S1     : PRINT"~K=(ALT-F1)/"
: RETURN
1110   LOCATE   1,1,0:   PRINT"~K=(ALT-F1),HW8/":  LOCATE
14,61:PRINT SPC(8)
1120   LOCATE 14,60:INPUT" ",GAP    : PRINT"~K=(ALT-F1)/"
: RETURN
1140   LOCATE  1,1,0:   PRINT"~K=(ALT-F1),HW9/"   : LOCATE
15,61:PRINT SPC(8)
1150   LOCATE 15,60:INPUT" ",FHH    : PRINT"~K=(ALT-F1)/"
1160   IF FHH <= 0 THEN PRINT"~W=DVN0/" : GOTO 1140 ELSE
RETURN
1180   LOCATE  1,1,0:   PRINT"~K=(ALT-F1),HW10/":  LOCATE
16,61:PRINT SPC(8)
1185          LOCATE     16,60:INPUT"    ",PASPEC          :
PRINT"~K=(ALT-F1)/" : RETURN
1190   LOCATE  1,1,0:   PRINT"~K=(ALT-F1),HW11/":  LOCATE
17,61:PRINT SPC(8)
1192    LOCATE 17,60:INPUT" ",AGL   : PRINT"~K=(ALT-F1)/"
: RETURN
```

```
200 LOCATE  1,1,0: PRINT"~K=(ALT-F1),TASCRUZ/": LOCATE
8,61:PRINT SPC(8)
205   LOCATE 18,60:INPUT" ",TASCR: PRINT"~K=(ALT-F1)/"
 RETURN
210   LOCATE  1,1,0:   PRINT"~K=(ALT-F1),HW12/":  LOCATE
9,61:PRINT SPC(8)
212   LOCATE 19,60:INPUT" ",TASMX: PRINT"~K=(ALT-F1)/"
 RETURN
220   LOCATE  1,1,0:   PRINT"~K=(ALT-F1),HW13/":  LOCATE
20,61:PRINT SPC(8)
222   LOCATE 20,60:INPUT" ",FF   : PRINT"~K=(ALT-F1)/"
1223    IF FF <= 0 THEN PRINT"~W=DVN0/" : GOTO 1220 ELSE
RETURN
1225 LOCATE 1,1,0: PRINT"~K=(ALT-F1),MXHVRALT/": LOCATE
21,61:PRINT SPC(8)
1227   LOCATE 21,60:INPUT" ",MXHVR: PRINT"~K=(ALT-F1)/"
1228    IF MXHVR   <= 0 THEN PRINT"~W=DVN0/" : GOTO 1225
ELSE RETURN
1230       '***************          ADMIN/CONTROL      SUBR
**********************************
123   OCATE 23,1: PRINT SPC(77)
123    LOCATE  23,13:INPUT"press  <Shift-PrtSc> for hard
copy   ENTER to continue",X5
1235  LS: LOCATE 1,1,0: PRINT"~W=COMP/"
1237  =299:TAS(I) = 0:PA  = MXHVR:TEMP=59:  GOSUB 1300:
PSPE HVR = PT(I)
1240   I=298:TAS(I)=TASCR:   PA=PASPEC:  TEMP=95:  GOSUB
1300:GOSUB 1800:  PTCRSP=PT(I)
1250 I=0:PA=0:  TEMP=59
1260 FOR I = 0 TO TASMX + 30 STEP 10
1270    TAS(I) = I   :   GOSUB 1300  :   GOSUB 1800    :
'compute power and hse
1280 NEXT I : PRINT"~C=ALL/": BEEP: CLS: GOSUB 3000 : '
print out results
1290 LOCATE 23,1: PRINT SPC(77)
1292 LOCATE  23,13:INPUT"press  <Shift-PrtSc>  for hard
copy. ENTER to continue",X5
1294 GOTO  4000 :'  calc losses  due to inlets,EAPS and
EEDS
1300       '***************    POWER   COMPUTATION   SUBR
**********************************
1301  IE   = 3.141592: RHO0 = 2.37691E-03 : RAD = 57.296
:  V  = FPM/60 = 0
130   NT =CNT + 1 :   RTRHT =  FHH +  .5 *  GAP :   GE =
(AG   RTRHT) / (2*R)
133   GE = .5147 + 1.3432*GE - 1.457*GE^2 + .708*GE^3 -
.12    E^4
134   '     = RPM/9.55 :  VT = RV  * R   :  VF =  TAS(I) *
1.6
134      DELTA=(1-6.87535E-06*PA)^5.256    :   THETA   =
(TE     9.69)/518.69
135      MA = DELTA / THETA                      :      RHO =
SIG     00
137      = VF / VT :       T = GW     :   S = B * C /(PIE
* R
14       LOSS=1-( SQR(2 * CT) / B)     :      RE  =  R *
TI       :    SR = S1 / R
14       =    2*RE^2*(PIE-(PIE/180)*ACOS(S1/(2*RE)))   +
S1*      ^2-S1^2/4)
146       GW /  (  RHO  *  AE  *  VT^2  )    :      VI =
SQR      RHO*AE))
147      1.46-.253*SR : AV =PIE*R^2 -2*R*GAP
150      =   SQR  (SQR  (.25*(AV/AE)^4*(VF/VI)^4+1)  -
.5*      E)^2*(VF/VI)^2)
15       L = 6*CT/S  :  AR = R/C     :   BL=CT/S :  DL =
GW       IE * R^2)
161      I) = T * VI * K * KU / 550
162      GE <= 2 THEN PI(I) = PGE * T * VI * K * KU /550
```

```
1630 PO(I)  = (CDO * B * C * R * VT^3 * RHO / 2200)*(1+
4.3 * MU^2)
1640 PP(I) = VF^3 * FF * RHO / 1100
1660 PT(I) = PI(I) + PO(I) + PP(I)  :     FM  = PI(I) /
(PI(I) + PO(I))
1680 RETURN
1800 '  ******  HIGH  SPEED EFFECTS ROUTINE w/ CONTROL
ANGLES ********
1805              IF                  TAS(I)=0              THEN
PTMIN=PT(I):PTMAX=PT(I):TASMINP=TAS(I):TASMAXP=TAS(I):
RETURN
1810 IF TAS(I) < 59 THEN RETURN
1820 B1  = TIPLOSS  : T7  = TWIST/RAD  : VIFF = (T/(2 *
RHO * AE * VF))
1890 LAMDA = -(PP(I)*550/GW + VIFF)/VT
1900 T1 = .5*(B1^2+.5*MU^2)          :   T2 = B1^3  /3 +
.5*MU^2*B1
1920 T3  = .25*  B1^2 *(B1^2  + MU^2)  :   T4 = .5* MU*
(B1^2 + MU^2/4)
1940 J2 = 2 * CT / (CLALFA *S) :  J3 = LAMDA *T1 :   J4
= J2 - J3- (T7 * T3)
1960 A11 = (4*((MU*(B1^2)/2)-(MU^3/8)))/(B1^2*(B1^2-.5*
MU^2))
1970 A12 = 8*MU*B1/(3*(B1^2-.5*MU^2))
1980 A13 = (2*B1^2 * MU)/(B1^2 - .5 * MU^2)
1985 A14=(B1^2+1.5*MU^2)/(B1^2-.5*MU^2)
1990   J5 = -LAMDA * A11 - (T7*A13)
2000   H8=(J4*A14-J5*T4)/(T2*A14-T4*A12)  :  COLANGLE =
H8*RAD
2010    H2=(J5*T2-J4*A12)/(T2*A14-T4*A12)  :  CYCLIC  =
H2*RAD
2030 K0= LAMDA/(1+MU) :  F  =  H8-H2+K0+T7  :  AOA270 =
F*RAD
2040 IF AOA270 < AOAST THEN PS(I)=0: GOTO 2060
2050 PS(I) = PO(I)*((AOA270 - AOAST)/4)
2060 GG = H8+H2+K0+T7  :  AOA90 = GG*RAD
2070                      MACHVEL                        =
49.042*(518.67*(1-.0000068755856#*PA))^.5
2080  MTIPHVR  =  (RV*R)/MACHVEL        :  MTIPFLT  =(
RV*R+VF)/MACHVEL
2090  M90  =  MTIPHVR*(1+MU):    IF MTIPFLT < MCRT THEN
PM(I)=0: GOTO 2120
2100 DMD  =  M90-MCRT  :  CPM=S*(.012*DMD+.1*(DMD^3)) :
PM(I)=(CPM*AE*RHO*VT^3)/550
2120 PT(I) = PI(I) + PO(I) + PP(I) + PS(I) + PM(I)
2140 IF PT(I) < PTMIN THEN PTMIN = PT(I) : TASMINP = I
2143 IF TAS(I) = TASCR THEN PTCR = PT(I)
2145 IF TAS(I) > TASMX THEN 2180
2150 IF PT(I) > PTMAX THEN PTMAX = PT(I) : TASMAXP = I
2180 RETURN
3000 '  ***********  HIGH SPEED EFFECTS/POWER RESULTS
OUTPUT SUBR **********
3003 IF PSPECHVR >PTMAX THEN PTMAX  = PSPECHVR: TASMAXP
= 0
3004   RSHP = PTMAX
3005 FOR I = 0 TO TASMX + 30 STEP 10
3010   IF TAS(I) = 0 THEN 3020
3011   IF TAS(I) = TASMINP THEN 3050
3012   IF TAS(I) = TASCR THEN 3050
3014   IF TAS(I) = TASMX THEN 3050
3018    I2  = (I+20)/20 : IF I2 - FIX(I2) = 0 THEN 3050
ELSE 3080
3020 PRINT"           * TOTAL POWER  (SHP) REQUIRED WITH
HIGH SPEED EFFECTS *"
3025 PRINT
3030 PRINT"     TAS(kts)    PI        PO        PP
 PS         PM         PT"
```

```
3040                                                          PRINT"
-------------------------------------------------------------------
------------------"
3050            PRINT                  USING"
######";TAS(I),PI(I),PO(I),PP(I),PS(I),PM(I),PT(I)
3080 NEXT I
3090 LOCATE 20,12: PRINT USING"MINIMUM POWER  = ###,###
SHP  AT #### knots";PTMIN,TASMINP
3100 LOCATE 21,12: PRINT USING"MAXIMUM POWER = ###,###
SHP  AT #### knots";PTMAX,TASMAXP
3110 LOCATE 22,12: PRINT USING"POWER AT HOVER CEILING =
###,### SHP  AT ##### ft MSL";PSPECHVR,MXHVR
3190 RETURN      :    'returns  to ADMIN/CONTROL SUBR at
line 1250
3900 '
4000 CLS: '******* ENGINE  INSTALLATION  LOSSES  SUBR &
OUTPUT ***************
4005 PRINT"                              * POWER REFINEMENTS --
INSTALLATION LOSSES *"
4010 PRINT
4015 PRINT"          I. - INLETS AND INLET DUCTING -"
4020 PRINT"             1. -S- TYPE ( 5% )"
4025 PRINT"             2. ICE SHIELD ( 10% )"
4030 PRINT"             3. STRAIGHT-IN ( 2% )"
4034 PRINT
4040 PRINT"         II. - ENGINE AIR PARTICLE SEPARATORS
-  EAPS"
4045 PRINT"              4. FOAM TYPE BARRIER FILTERS  (
10% )"
4050 PRINT"                    5.  POWER  (  HYDRAULIC )
SEPARATORS  ( 2 - 6% )"
4055 PRINT"             6. NONE INSTALLED"
4060 PRINT
4070  PRINT"             III. - ENGINE EXHAUST DEVICES -
EEDS"
4075 PRINT"             7. SIMPLE HEAT DIFFUSER  ( 3% )"
4080 PRINT"             8. INFRA-RED SUPPRESSOR  ( 5% )"
4085 PRINT"             9. NONE INSTALLED"
4100 GOSUB  4200: GOSUB  4230: GOSUB  4260: GOSUB 4280:
GOTO 4300
4200 LOCATE 23,1: PRINT SPC(77)
4202  LOCATE  23,10:  INPUT"SELECT  THE  DESIRED  INLET
SYSTEM ",Y1
4204  IF Y1 < 1  OR Y1 > 3 THEN GOSUB 4500: GOTO 4200
4208  ON Y1 GOSUB 4220,4224,4228
4212  PINLET = INLET * 100 : RSHPINLT = RSHP * INLET
4216  LOCATE 6,42:  PRINT USING  "INLET LOSSES  = #####
SHP  ###.# %";RSHPINLT,PINLET
4218 RETURN
4220   INLET   =.05:LOCATE   4,9    :  PRINT"***":LOCATE
5,9:PRINT"   ":LOCATE 6,9:PRINT"   ":RETURN
4224   INLET   =.1    :LOCATE   5,9    :  PRINT"***":LOCATE
4,9:PRINT"   ":LOCATE 6,9:PRINT"   ":RETURN
4228   INLET   =.02:LOCATE   6,9    :  PRINT"***":LOCATE
4,9:PRINT"   ":LOCATE 5,9:PRINT"   ":RETURN
4229 '
4230 LOCATE 23,1: PRINT SPC(77)
4232  LOCATE  23,10:  INPUT"SELECT  THE  DESIRED  EAPS
SYSTEM  ",Y1: Y1=Y1-3
4234  IF Y1 < 1 OR Y1 > 3 THEN GOSUB 4500: GOTO 4230
4238  ON Y1 GOSUB 4248,4250,4252
4242  PEAPS = EAPS * 100 : RSHPEAPS = RSHP * EAPS
4246  LOCATE 11,42:  PRINT USING  "EAPS LOSSES = #####
SHP  ###.# %";RSHPEAPS,PEAPS
4247 RETURN
4248  EAPS   =   .1:   LOCATE   9,9:  PRINT"***":LOCATE
10,9:PRINT"   ":LOCATE 11,9:PRINT"   ":RETURN
```

```
4250   EAPS   =.04:   LOCATE   10,9:   PRINT"***":LOCATE
9,9:PRINT"    ":LOCATE 11,9:PRINT"    ":RETURN
4252   EAPS   =   0   :   LOCATE   11,9:   PRINT"***":LOCATE
9,9:PRINT"    ":LOCATE 10,9:PRINT"    ":RETURN
4259 '
4260 LOCATE 23,1: PRINT SPC(77)
4261   LOCATE   23,10:   INPUT"SELECT   THE   DESIRED   EEDS
SYSTEM    ",Y1: Y1=Y1-6
4262   IF Y1 < 1 OR Y1 > 3 THEN GOSUB 4500: GOTO 4260
4264   ON Y1 GOSUB 4277,4278,4279
4272   PEEDS = EEDS * 100 : RSHPEEDS = RSHP * EEDS
4274   LOCATE 16,42:   PRINT USING   "EEDS LOSSES   = #####
SHP   ###.# %";RSHPEEDS,PEEDS
4276 RETURN
4277   EEDS   =.03:   LOCATE   14,9:   PRINT"***":LOCATE
15,9:PRINT"    ":LOCATE 16,9:PRINT"    ":RETURN
4278   EEDS   =.05:   LOCATE   15,9:   PRINT"***":LOCATE
14,9:PRINT"    ":LOCATE 16,9:PRINT"    ":RETURN
4279   EEDS   =   0   :   LOCATE   16,9:   PRINT"***":LOCATE
15,9:PRINT"    ":LOCATE 14,9:PRINT"    ":RETURN
4280   '***   total   losses   computation   subr
*****************************
4281   ENGNLOST   =   RSHP*(INLET+EAPS+EEDS)   : MISCLOST =
RSHP*(.05*ENGN+.03)+10
4282 PCTENGN   = ENGNLOST*100/RSHP              : PCTMISC =
MISCLOST*100/RSHP
4284 RSHPLOST = ENGNLOST + MISCLOST
4286 ESHP   = RSHP   + RSHPLOST                 : PCTLOST =
RSHPLOST*100/ESHP
4288 LOCATE 18,12: PRINT   USING"ENGINE,   XMSN   and MISC
INSTALLATION     LOSSES     =     #####     SHP     ###.#
%":MISCLOST,PCTMISC
4290 LOCATE 19,12: PRINT USING"                TOTAL LOSSES
(percent     of     ESHP)     =     #####     SHP     ###.#
%":RSHPLOST,PCTLOST
4292 LOCATE 20,12: PRINT USING"              MAXIMUM POWER
REQUIRED [RSHP] = ###,### SHP";RSHP
4294   LOCATE   21,10:   PRINT   USING"*   ENGINE   SHAFT
HORSEPOWER REQUIRED [ESHP] = ###,### SHP";ESHP
4296 FLG3 = 1 : RETURN
4300 LOCATE 23,1: PRINT SPC(77)
4305 LOCATE 23,13: INPUT"ANY   CHANGES   ?   (0=N0, 1=YES)
",ANS
4310 IF   ANS=0 THEN   4370 ELSE   IF ANS=1 THEN 4340 ELSE
GOSUB 4500: GOTO 4300
4340 LOCATE 23,45: INPUT" WHICH   ITEM   ?     (1,2   or 3)
",X5
4344 IF X5 < 1 OR X5 > 3 THEN GOSUB 4500: GOTO 4340
4350 ON X5 GOSUB 4200,4230,4260
4360 GOSUB 4280 : GOTO 4300
4370 LOCATE 23,1: PRINT SPC(77)
4375   LOCATE   23,13:INPUT"press   <Shift-PrtSc> for hard
copy, ENTER to continue",X5
4380 GOTO 100
4500 LOCATE   1,1,0: PRINT"~W=TRYAGAIN/"   : LOCATE 23,1:
PRINT SPC(77): RETURN
9000     CLS:     PRINT"~C=ALL/":     PRINT"~W=LOADNOTE/":
CHAIN"TR1",,ALL
9999 END
10 'PROGRAM"TR6.BAS" 17 SEPT 87
20 KEY OFF : B$="#####" : C$="#.###"
30
'*****************************************************-
***********
40 '*                  *** ENGINE & XMSN SELECTION ***
          *
50
```

```
'*************************************************************
***********
70 '                              ***  CHAPTER SIX MAIN PROGRAM
***
80 '
100 PRINT"~C=ALL/":PRINT"~L=TANDEM6/"
120                   COLOR                    1,1,1:CLS:LOCATE
23,1,0:PRINT"~W=ENGMENU/":INPUT"",X
130 COLOR 15,1 : ON X GOSUB 200,300,400  : GOTO 120
160 '
200                   COLOR                    1,1,1:CLS:LOCATE
23,1,0:PRINT"~W=ENGNSELN/":INPUT"",X6 :RETURN
210
300 'temporary data for weight summation, power etc.
310 'ENGN = 2  : W(1,1)=2625 : W(3,1)=3333 : W(4,1)=600
: W(5,1)=2100
320 'W(6,1)=2800 : W(7,1)=780 : W(8,1)=130 : W(9,1)=140
: W(10,1)=100
330     'W(11,1)=500:     W(12,1)=400     :    W(13,1)=700:
W(14,1)=150: W(15,1)=190
340                   'W6A(1)=900:W6B(1)=1600:W6C(1)=300:
MGW=23000:R=25.5:C=1.5:CDO=.009
342                                        'B=3:RPM=267.4:
S1=34:GAP=4:FHH=12:PA=0:TAS=0:AGL=10:NENG=2:ESHP=2600
344
'PAX=6250:FUEL=2500:UL=1000:RHO=.002377:PIE=3.14159:
RHO0=.002377
350 GOTO 500
360 '
400                                                    LOCATE
23,1,0:CLS:PRINT"~W=LOADNOTE/":CHAIN"TR1",,ALL
460
500     '     *************    SECTION    6.1    &    6.2
*****************************
510 CLS
512 LOCATE  1,28: PRINT"* NUMBER OF ENGINES *
    (SECTION 6.1)"
516 LOCATE 2,10:  PRINT"1. NUMBER OF ENGINES = ";ENGN
520 LOCATE 2,44:  PRINT"(specified in Chapter 3)
530 LOCATE 3,28:  PRINT" * TYPE OF ENGINES *
    (SECTION 6.2)"
540 LOCATE  4,10: INPUT"2.  NUMBER OF ENGINES COMPETING
FOR SELECTION ";NENGSEL
550 LOCATE 23,33: PRINT"       ":LOCATE  23,5: INPUT"ANY
CHANGES ? (0=NO, 1=YES) ",ANS
560  IF  ANS=0  THEN  605   ELSE IF ANS=1 THEN 570 ELSE
BEEP: GOTO 550
570 LOCATE 23,38: INPUT"WHICH ITEM ? (1 or 2) ",X6
580 ON X6 GOSUB  590,595 :  LOCATE 23,1:  PRINT SPC(75)
:GOTO 550
585 '
590   LOCATE   2,33:   PRINT   SPC(3):   LOCATE   2,34:
INPUT"",ENGN : RETURN
595   LOCATE   4,55:   PRINT   SPC(3):   LOCATE   4,56:
INPUT"";NENGSEL: RETURN
600 '
605                        LOCATE                      5,2:
PRINT"=============================================
=============================="
606 LOCATE 23,1: PRINT SPC(75)
610 LOCATE 6,25:PRINT"* ENGINE SELECTION PARAMETERS *"
611 PRINT"                ENGINE:"
613 PRINT"   3. DRY WEIGHT (lbs)......"
614 PRINT"   4. SHP (ssl) military...."
615 PRINT"   5. SFC (ssl) military...."
616 PRINT"   6. INITIAL COST..... $K "
620 PRINT"   7. OP COST/HR/ENG..... $ "
622 PRINT"   8. PREV MAINT/HR/ENG.. $ "
```

```
631 PRINT"    9.     MTBMA (hrs)........."
632 PRINT"   10.     MDT (hrs)..........."
633 PRINT"   11.     MTBF (hrs)........."
634 PRINT"   12.     MTBR (hrs)........."
640 K=32:KK=30:FOR I=1 TO NENGSEL:IF I=1 THEN A$="A"
ELSE IF I=2 THEN A$="B":ELSE IF I=3 THEN A$="C" ELSE IF
I=4 THEN A$="D" ELSE IF I=5 THEN A$="E"
650      LOCATE 7,K : PRINT A$
651      LOCATE 8,KK: INPUT;"",DW(I)
652      LOCATE 9,KK: INPUT;"",SHP(I)
653      LOCATE 10,KK:INPUT;"",SFC(I)
654      LOCATE 11,KK:INPUT;"",IC(I)
655      LOCATE 12,KK:INPUT;"",OC(I)
656      LOCATE 13,KK:INPUT;"",PMA(I)
657      LOCATE 14,KK:INPUT;"",MTBMA(I)
660      LOCATE 15,KK:INPUT;"",MDT(I)
661      LOCATE 16,KK:INPUT;"",MTBF(I)
662      LOCATE 17,KK:INPUT;"",MTBR(I)
670 LOCATE 23,5:INPUT"ANY CHANGES ? (0=NO,1=YES) ",ANS
680   IF ANS=0 THEN 720   ELSE IF  ANS=1 THEN  690 ELSE
BEEP: GOTO 710
690   LOCATE 23,38: INPUT"WHICH ITEM ? (3 thru 12) ",X6
: X6=X6-2
700                                ON          X6        GOSUB
780,784,788,792,794,796,798,800,802,804
710 LOCATE 23,1: PRINT SPC(75): GOTO 670
720 K=K+10 : KK=KK+10 :LOCATE 23,1: PRINT SPC(75): NEXT
I
725 '
730 FOR  I=1  TO  3:  LOCATE  18+I,67:PRINT SPC(9):NEXT
I:LOCATE 23,1:PRINT SPC(75)
731 LOCATE 19,10
732   INPUT"13. SPECIFICATION  AVERAGE FLIGHT HOURS PER
YEAR ..... ";AFL
734 LOCATE 20,10
735   INPUT"14. SPECIFICATION  AVERAGE AIRFRAME SERVICE
LIFE IN YEARS ";SL
737 LOCATE 21,10
738      INPUT"15.  AVERAGE   FLIGHT  HOURS  PER  FLIGHT
.....;.............. ";TAV
740
745 LOCATE 23,5:INPUT"ANY CHANGES ? (0=NO, 1=YES) ",ANS
747 IF ANS=0 THEN  750  ELSE  IF  ANS=1  THEN  730 ELSE
BEEP:LOCATE 23,1: PRINT SPC(38) : GOTO 745
750 LOCATE 23,1: PRINT SPC(75)
752  LOCATE  23,13:INPUT"press  <Shift-PrtSc>  for hard
copy, ENTER to continue",X6
755
760 FOR I=1  TO  NENGSEL  :  RD(I)=0  :  'R  &  D costs
included in the IC
764        YM(I)=PMA(I)*AFL/1000: YO(I)=OC(I)*AFL/1000:
NRPL1=AFL*SL/MTBR(I)
766    NRPL(I)=NENG*(CINT(NRPL1))
767
LC(I)=ENGN*(RD(I)+IC(I)+(SL*(YO(I)+YM(I)))+(NRPL(I)
*((1.35*IC(I))-(.8*IC(I)))
768    AVAIL(I)=MTBMA(I)/(MTBMA(I)+MDT(I))
770              MAINT(I)=(MDT(I)/(MTBMA(I)+MDT(I)))*TAV:
RELY(I)=EXP(-TAV/MTBF(I))
771    RC(I)=1.35*IC(I):SV(I)=.8*IC(I)
772 NEXT I :  GOTO 840
774 '
775 '  ***********  ENGINE  SELECTION  PARAMETER INPUT
CHANGE SUBR ***********
776 '
780              LOCATE  8,KK:   PRINT  SPC(7):LOCATE
8,KK:INPUT;"",DW(I) : RETURN
```

```
784                 LOCATE   9,KK:    PRINT   SPC(7):LOCATE
9,KK:INPUT;"",SHP(I): RETURN
788                 LOCATE   10,KK:PRINT    SPC(7):LOCATE
10,KK:INPUT;"",SFC(I): RETURN
792                 LOCATE    11,KK:PRINT   SPC(7):LOCATE
11,KK:INPUT;"",IC(I)  : RETURN
794                 LOCATE   12,KK:PRINT    SPC(7):LOCATE
12,KK:INPUT;"",OC(I)  : RETURN
796                 LOCATE    13,KK:PRINT   SPC(7):LOCATE
13,KK:INPUT;"",PMA(I): RETURN
798                 LOCATE   14,KK:PRINT    SPC(7):LOCATE
14,KK:INPUT;"",MTBMA(I): RETURN
800                 LOCATE   15,KK:PRINT    SPC(7):LOCATE
15,KK:INPUT;"",MDT(I)  : RETURN
802                 LOCATE   16,KK:PRINT    SPC(7):LOCATE
16,KK:INPUT;"",MTBF(I) : RETURN
804                 LOCATE   17,KK:PRINT    SPC(7):LOCATE
17,KK:INPUT;"",MTBR(I) : RETURN
810 '
820 '
840 FOR I=1 TO NENGSEL
841     IF DW(I)<=300 THEN GOTO 850 ELSE
842     IF DW(I)>300 AND DW(I)<=700 GOTO 860 ELSE
844       IF DW(I)>700  AND DW(I)<=1100 GOTO 870 ELSE IF
DW(I)>1100 GOTO 880
850    EWT(I)=DW(I)*1.29: GOTO 890
860    EWT(I)=DW(I)*1.27: GOTO 890
870    EWT(I)=DW(I)*1.24: GOTO 890
880    EWT(I)=DW(I)*1.2: GOTO 890
890 NEXT I
940 '
950 '
960 '                              *** SECTION 6.3 & 6.4 ***
970 '
980 '
990 CLS:LOCATE 1,25:PRINT"* ENGINE SELECTION CRITERIA *
    ( 6.3 & 6.4 )"
991     LOCATE    3,38:PRINT"----------------    ENGINE
----------------"
992 LOCATE 4,39:PRINT"A        B        C        D
  E"
993   PRINT
994   PRINT"   POWERPLANT WEIGHT(installed)....  "
995   PRINT"   LIFE-CYCLE COST ..............K$  "
1000  PRINT"       ENGINE LIFE (hrs).........  "
1001  PRINT"       No. OF REPLACEMENTS.......  "
1002  PRINT"       R/D COSTS.................K$  "
1003  PRINT"       INITIAL COSTS.............K$  "
1004  PRINT"       ANNUAL MAINT. COST........K$  "
1005  PRINT"       ANNUAL OPERATING COST.....K$  "
1006  PRINT"       REPLACEMENT COST..........K$  "
1010  PRINT"       SALVAGE VALUE.............K$  "
1011  PRINT"   AVAILABILITY (per engine)....... "
1012  PRINT"   RELIABILITY (per engine)........ "
1013  PRINT"   MAINTAINABILITY (per engine).... "
1014  PRINT"   PERFORMANCE (military SHP)...... "
1020  K1=37:  FOR I=1 TO NENGSEL
1021      LOCATE 6,K1:PRINT USING B$;EWT(I)
1022      LOCATE 7,K1:PRINT USING B$;LC(I)
1023      LOCATE 8,K1:PRINT USING B$;MTBR(I)
1024      LOCATE 9,K1:PRINT USING B$;NRPL(I)
1025      LOCATE 10,K1:PRINT USING B$;RD(I)
1026      LOCATE 11,K1:PRINT USING B$;IC(I)
1030      LOCATE 12,K1:PRINT USING B$;YM(I)
1031      LOCATE 13,K1:PRINT USING B$;YO(I)
1032      LOCATE 14,K1:PRINT USING B$;RC(I)
1033      LOCATE 15,K1:PRINT USING B$;SV(I)
1034      LOCATE 16,K1:PRINT USING C$;AVAIL(I)
```

```
1035     LOCATE 17,K1:PRINT USING C$;RELY(I)
1040     LOCATE 18,K1:PRINT USING C$;MAINT(I)
1041     LOCATE 19,K1:PRINT USING B$;SHP(I):K1=K1+9
1050 NEXT I
1060 IF NENGSEL=1 THEN EN=1:GOTO 1080 ELSE
1061 LOCATE 21,1:PRINT SPC(77):LOCATE 21,12
1065  INPUT"ENTER  THE  LETTER  OF  THE SELECTED ENGINE
(i.e. A,B,C) ",D$
1070 IF  D$="A" THEN  EN=1: GOTO  1080   ELSE IF D$="a"
THEN EN=1: GOTO 1080
1072 IF  D$="B" THEN  EN=2: GOTO  1080   ELSE IF D$="b"
THEN EN=2: GOTO 1080
1074 IF  D$="C" THEN  EN=3: GOTO  1080   ELSE IF D$="c"
THEN EN=3: GOTO 1080
1076 IF  D$="D" THEN  EN=4: GOTO  1080   ELSE IF D$="d"
THEN EN=4: GOTO 1080
1078 IF  D$="E" THEN  EN=5: GOTO  1080   ELSE IF D$="e"
THEN EN=5: GOTO 1080 ELSE 1060
1080 LOCATE 22,1: PRINT SPC(75)
1085  LOCATE  23,5:INPUT"ANY  CHANGES  ?  (0=NO, 1=YES)
",ANS
1090 IF ANS=0 THEN  1095 ELSE  IF ANS=1  THEN 1061 ELSE
BEEP: GOTO 1080
1095 LOCATE 23,1: PRINT SPC(77)
1100  LOCATE  23,13:INPUT"press  <Shift-PrtSc> for hard
copy, ENTER to continue",X6
1110 '
1130 '                                  *** SECTION 6.5 ***
1150 CLS
1155  LOCATE  2,5:  PRINT"*  TRANSMISSION  SELECTION  *
(6.5)"
1160 LOCATE 4,3: PRINT USING"ENGINES:    TOTAL SHAFT HP
= ######.# SHP"; ESHP
1165 LOCATE 5,3: PRINT USING"          NUMBER INSTALLED
= ######  "; ENGN
1170 LOCATE 6,3: PRINT USING"          INSTALLED WEIGHT
= ######.# lbs";EWT(EN)
1171 LOCATE 1,1:COLOR 1,1,1
1172     PRINT"~W=XMSNMENU/":INPUT"",XM:ON    XM   GOSUB
1210,1212,1214,1216,1218,1220
1173 COLOR 15,1: PRINT"~C=ALL/"
1174 LOCATE 7,3: PRINT USING"TRANSMISSION: POWER RATING
= ######.# SHP"; XMSNP
1176 LOCATE 8,3: PRINT USING"                    WEIGHT
= ######.# lbs"; XMSNW
1178                          LOCATE                  9,2:
PRINT"=========================================="
1180       GOSUB      1250:      GOSUB      1800:LOCATE
1,1,0:PRINT"~C=ALL/": GOSUB 2465
1182  LOCATE  10,2:  PRINT"              REVISED WEIGHT
ESTIMATES "
1184 LOCATE 12,3: PRINT USING"           A/C  EMPTY WT
= ######.#";WE2
1186 LOCATE  13,3: PRINT  USING"               FUEL WT
= ######.#";FUEL
1188 LOCATE 14,3: PRINT USING"            PERSONNEL WT
= ######.#";PAX
1190 LOCATE  15,3: PRINT  USING"           USEFUL LOAD
= ######.#";UL
1192                       LOCATE                    16,2:
PRINT"----------------------------------------"
1194 LOCATE  17,3: PRINT  USING"      GROSS WT ESTIMATE
= ######.# lbs";GW(NN)
1196 LOCATE 18,3: PRINT USING"    TOTAL  POWER FOR HOGE
= ######.# SHP";PT
1197 LOCATE  19,3: PRINT  USING"          DISK LOADING
= ##.#### psf";DL
```

```
1198 LOCATE 20,3: PRINT USING"                FIGURE OF MERIT
= ##.####";FM
1200 '
1203  LOCATE  23,13:INPUT"press  <Shift-PrtSc> for hard
copy, ENTER returns to MENU",X6
1204 GOTO 120
1205 '
1210 XMSNP = 1150 : XMSNW =  700 : RETURN
1212 XMSNP = 1900 : XMSNW = 1100 : RETURN
1214 XMSNP = 3100 : XMSNW = 1700 : RETURN
1216 XMSNP = 4400 : XMSNW = 3000 : RETURN
1218 XMSNP = 5700 : XMSNW = 4000 : RETURN
1220 XMSNP = 8500 : XMSNW = 6500 : RETURN
1225 '
1230 '                                  *** SECTION 6.6 ***
1250   '************   NEW    WEIGHT    SUMMATION   SUBR
**********************************
1260 LOCATE 1,1,0: PRINT"~W=COMP/"
1270  NN=1: W(6,NN)=W6C(NN)+XMSNW+(ENGN*EWT(EN)): WE2=0
1271    FOR I=1 TO 15
1272    WE2=WE2+W(I,NN)
1273    NEXT I
1275 NGW=WE2+FUEL+UL+PAX
1280 N = NN : GW(N) = NGW : RETURN
1290 '
1800   '********************   POWER   COMPUTATION  SUBR
************************
1820 '
1830 CNT =CNT + 1
1840 RTRHT = FHH + .5 * GAP
1850 GE = (AGL+RTRHT) / (2*R)
1860 PGE =  .5147 + 1.3432*GE - 1.457*GE^2 + .708*GE^3 -
.1276*GE^4
1870 RV   =  RPM/9.55 :   VT  = RV  * R  :   VF = TAS *
1.68893
1880 SIGMA = (1 - 6.87535E-06 * PA)^4.2561
1890  IF  PA=0  THEN  RHO=RHO0  ELSE  IF  PA=4000  THEN
RHO=.001918 ELSE RHO=SIGMA*RHO0 :'lb-sec^2/ft^4
1900 MU = VF / VT
1910 T = 1.055 * GW(N)
1920 S = B * C /(PIE * R)
1930 TIPLOSS = 1 - ( SQR(2 * CT) / B)
1940 RE = R * TIPLOSS
1950 SR = S1 / R
1960   AE=   2*RE^2*(PIE-(PIE/180)*ACOS(S1/(2*RE)))   +
S1*SQR(RE^2-(S1^2)/4)
1965 CT = T / ( RHO * AE * VT^2 )
1970 K = 1.46 - .253 * SR
1980 AV = PIE * R^2 - 2 * R * GAP
1990 VI = SQR(T/(2*RHO*AE))
2000   KU    =   SQR(SQR(1+.25*((AV/AE)*(VF/VI))^4)   -
.5*((AV/AE)*(VF/VI))^2)
2004 DL = GW(N) /(2 * PIE * R^2)
2006 CL = 6 * CT/S
2007 AR = R/C
2008 BL = CT / S
2009 IF  B*C*R/S1 > 3.75 THEN COLOR 1,1,1:LOCATE 1,1,0:
PRINT"~W=BLDSTRK/":INPUT X4 :PRINT"~C=ALL/": COLOR 15,1
2020 '
2030 '                          *** POWER CALCULATION  ***
2040 '
2060 IF GE <= 2 THEN PI = PGE * T *  VI *  K *  KU /550
ELSE
2070 PI = T * VI * K * KU / 550
2080 PO = (CDO * B * C * R * VT^3 * RHO / 2200)*(1+ 4.3
* MU^2)
2090 PP = VF^3 * FF * RHO / 1100
2100 PC = (T * VV + RHO * FF * VV^3 ) / 1100
```

```
2105 FM = PI / (PI + PO)
2110 PT = PI + PO + PP + PC
2120 RETURN
2130 '
2465 '  ********** COMP  WT  RESULTS  OUTPUT  SUBR
**************************
2468 '
2469 LOCATE 2,47  :  PRINT"  * REVISED  COMPONENT WT
(6.6)"
2470 LOCATE  4,47  :  PRINT  USING"  1.  MAIN  ROTORS
.....  #####.#"; W(1,NN)
2475 LOCATE  5,47  :  PRINT  USING"  2.  FUSELAGE
.....  #####.#"; W(3,NN)
2480 LOCATE  6,47  :  PRINT  USING"  3.  LANDING  GEAR
.....  #####.#"; W(4,NN)
2485 LOCATE  7,47  :  PRINT  USING" 4. ENGINE NACELLES
.....  #####.#"; W(5,NN)
2490 LOCATE  8,47  :  PRINT  USING"  5.  ENGINES
.....  #####.#"; W6A(NN)
2495 LOCATE  9,47  :  PRINT USING" 6. DRIVE TRAIN/XMSN
.....  #####.#"; W6B(NN)
2500 LOCATE  10,47:  PRINT  USING"  7.  FUEL  TANKS
.....  #####.#"; W6C(NN)
2505 LOCATE  11,47:  PRINT  USING"  8. FLIGHT CONTROLS
.....  #####.#"; W(7,NN)
2510 LOCATE 12,47:  PRINT  USING"  9.  AUX  POWER (APU)
.....  #####.#"; W(8,NN)
2515 LOCATE  13,47:  PRINT  USING"10.  INSTRUMENTS
.....  #####.#"; W(9,NN)
2520 LOCATE  14,47:  PRINT  USING"11.  HYDRAULIC SYSTEM
.....  #####.#"; W(10,NN)
2525 LOCATE  15,47:  PRINT USING"12. ELECTRICAL SYSTEM
.....  #####.#"; W(11,NN)
2530 LOCATE  16,47:  PRINT  USING"13.  AVIONICS
.....  #####.#"; W(12,NN)
2535 LOCATE  17,47:  PRINT  USING"14.  FURNISHINGS
.....  #####.#"; W(13,NN)
2540 LOCATE  18,47: PRINT  USING"15. AC  / DE-ICE EQUIP
.....  #####.#"; W(14,NN)
2545 LOCATE  19,47:  PRINT  USING"16.  LOAD  HANDLING
EQUIP.. #####.#"; W(15,NN)
2550                    LOCATE                  20,47:
PRINT"-----------------------------------"
2555 LOCATE 21,46: PRINT USING"REVISED COMPONENT WEIGHT
= #####.#"; WE2
2560 RETURN
9999 END
10  ' PROGRAM TR7.BAS.......19 SEPT 1987                 '
20
**********************************************************
30 '  *              *** RANGE AND ENDURANCE ***
*
40                                                       '
**********************************************************
50 KEY OFF: PRINT "~L=TANDEM7/" : PRINT "~C=ALL/"
60 COLOR 15,1
70  DIM  ANG(200):IF  ENGN=0  THEN  ENGN=2  'FUEL=2400:
PTCR=1800:PTCRSP=1890: PTMIN=1400
80      'TASMINP=70:       TASCR=130:          TASMX=150:
PT(70)=1400:PT(80)=      1500:PT(90)=      1610:PT(100)=
1730:PT(110)= 1860:PT(120)= 2050:PT(130)= 2300:PT(140)=
2600: PT(150)= 3000
90 '
100 CLS
110 LOCATE  1,27: PRINT"  * RANGE  and ENDURANCE  *
(Chap 7)"
120 PRINT"
```

```
130 PRINT"                1. SFC (lb/hr/shp)      2.  SHP
    FUEL FLOW (lb/hr)"
140 PRINT"    MILITARY:
150 PRINT"      NORMAL:
160 PRINT"      CRUISE:
170 PRINT"
180 PRINT"      3.  SPECIFICATION CONDITIONS:   ALTITUDE
=          TEMP = "
190 PRINT"                ZERO HORSEPOWER INTERCEPT = "
200 PRINT"                     PHANTOM HORSEPOWER = "
210  PRINT" ========================================
==================================="
220 PRINT"                * MAX RANGE *                 :
    * MAX ENDURANCE *"
230 PRINT"                                             :"
240 PRINT"                                             :"
250 PRINT"                                             :"
260 PRINT"                                             :"
270  PRINT" ========================================
==================================="
280 PRINT"    *  CRUISE PWR & FUEL FLOW:              * :
* TOTAL FUEL REQUIREMENTS *"
290 PRINT"         (ssl)                (spec)        :"
300 PRINT"                                             :"
310 PRINT"                                             :"
320 PRINT"                                             :"
350 GOSUB 400: GOSUB 450: GOSUB  500: GOSUB  600: GOSUB
630
360 GOSUB 800: GOSUB 1000: GOSUB 1100: GOSUB 1120: GOTO
1200
390 '
400          '****          SFC          INPUT          SUBR
*****************************************************
401 '
403 LOCATE 23,1: PRINT SPC(77): COLOR 14,1
405  LOCATE   23,10:  PRINT"  1.  ENTER  SPECIFIC  FUEL
CONSUMPTION FOR EACH POWER SETTING.": COLOR 15,1
410 LOCATE 4,21:PRINT"          ": LOCATE 4,21:  INPUT" ",
SFC(1): IF SFC(1)=0 THEN PRINT"~W=DVN0/":GOTO 410
420 LOCATE  5,21:PRINT"          ": LOCATE 5,21: INPUT" ",
SFC(2): IF SFC(2)=0 THEN PRINT"~W=DVN0/":GOTO 420
430 LOCATE 6,21:PRINT"          ": LOCATE 6,21:  INPUT" ",
SFC(3): IF SFC(3)=0 THEN PRINT"~W=DVN0/":GOTO 430
445 RETURN
449 '
450       '***       SHP       RATING       INPUT       SUBR
*************************************
451 '
453 LOCATE 23,1: PRINT SPC(77): COLOR 14,1
455 LOCATE 23,10: PRINT"  2. ENTER  RATED SHP  FOR EACH
POWER SETTING.": COLOR 15,1
460 LOCATE 4,37:PRINT"          ": LOCATE 4,37: INPUT" ",
SHP(1): IF SHP(1)=0 THEN PRINT"~W=DVN0/":GOTO 460
470 LOCATE 5,37:PRINT"          ": LOCATE 5,37: INPUT" ",
SHP(2): IF SHP(2)=0 THEN PRINT"~W=DVN0/":GOTO 470
480 LOCATE 6,37:PRINT"          ": LOCATE 6,37: INPUT" ",
SHP(3): IF SHP(3)=0 THEN PRINT"~W=DVN0/":GOTO 480
490 LOCATE 23,1: PRINT SPC(77)
495 RETURN
499 '
500     '***      COMPUTE     &      OUTPUT     FUEL     FLOW
*********************************
501 '
505 FOR I = 1 TO 3
510     WDOTF(I) = SFC(I) * SHP(I) * ENGN
520 NEXT I
530 LOCATE 4,53: PRINT USING" #####.##";WDOTF(1)
540 LOCATE 5,53: PRINT USING" #####.##";WDOTF(2)
```

```
550 LOCATE 6,53: PRINT USING" #####.##";WDOTF(3)
595 RETURN
599 '
600 '***      spec      condition      input      subr
**.**********************************
601 '
603 LOCATE 23,1: PRINT SPC(77) : COLOR 14,1
605  LOCATE  23,6:   PRINT"   3.   ENTER  SPECIFICATION
CONDITIONS  --  NORMALLY  4000  ft MSL 95 deg F": COLOR
15,1
610 LOCATE 8,49: PRINT"        ": LOCATE 8,49: INPUT" ",
ALT
620 LOCATE 8,65: PRINT"        ": LOCATE 8,65: INPUT" ",
TEMP
625 RETURN
629 '
630 '*** compute & output 0 HP interceptand  phantom HP
*************
631 '
640 BETAH=(WDOTF(1)-WDOTF(3))/(ENGN*(SHP(1)-SHP(3)))
650 ALPHAH=WDOTF(1)-(ENGN*BETAH*SHP(1))
660 DELTA(1)=1:  DELTA(2)=(1-6.87535E-06*ALT)^5.2561
670 THETA(1)=1:  THETA(2)=(459.688+TEMP)/518.688
680              FOR                I=1              TO              2:
ALPHAH(I)=ALPHAH*DELTA(I)*SQR(THETA(I)): NEXT I
690 FOR I=1 TO 2: PF(I)=ALPHAH(I)/BETAH: NEXT I
750 LOCATE   9,10:PRINT  USING"     ZERO  HP INTERCEPT =
+####.## (ssl)    +####.## (spec)";ALPHAH(1),ALPHAH(2)
760  LOCATE  10,10:PRINT  USING"   PHANTOM HORSEPOWER =
+####.## (ssl)    +####.## (spec)";PF(1),PF(2)
770 RETURN
780 'LOCATE 23,1: PRINT SPC(77): COLOR 14,1
782  'LOCATE  23,5:  INPUT"ANY  CHANGES  ? (0=NO,1=YES)
",ANS
785 '   IF  ANS=0 THEN  800 FLSE IF ANS=1 THEN 790 ELSE
BEEP: GOTO 798
790 '  LOCATE 23,38: INPUT"WHICH ITEM (1 thru 3) ",X7
794 '  ON X7 GOSUB 400,450,600
798 'GOTO 780
799 '
800 '*** COMPUTE Range  airspeed and  power then output
**********************
801 '
805 PRINT"~W=COMP/"
809 ANG(TASMINP-10) = 999
810  FOR I = TASMINP TO TASMX STEP 10 :' change to step
1,ANG(I-10) too!!
820    PWR = PF(I) + PT(I) :  TAS(I) = I
830    ANG(I) = PWR/TAS(I)
840              IF    ANG(I)    <    ANG(I-10)   THEN
RHPMXR=PWR:PTMXR=PWR-PF(1):TASMXR=TAS(I)
850  NEXT I
860 FFMXR =  RHPMXR * BETAH :  PRINT"~C=ALL/"
870  LOCATE  13,8  :  PRINT  USING"  AIRSPEED =      ###
kts";TASMXR
880 LOCATE 14,8 : PRINT  USING"         POWER  = ###,###
SHP";PTMXR
890  LOCATE  15,8  :  PRINT  USING"FUEL  FLOW = ###,###
lb/hr";FFMXR
900 '*** COMPUTE MAX Endurance  fuel  flow,  A/S  and P
from HSE program ****
910 RHPMXE = PF(1) + PTMIN : FFMXE = RHPMXE * BETAH
920 LOCATE  13,48 :  PRINT USING"  AIRSPEED =        ###
kts";TASMINP
930 LOCATE 14,48 : PRINT USING"         POWER  = ###,###
SHP";PTMIN
940  LOCATE  15,48  :  PRINT  USING"FUEL FLOW = ###,###
lb/hr";FFMXE
```

```
950 '
1000  '***  COMPUTE  SPEC  cruise  pwr  and  fuel  flow
*****************************
1001 '
1010 RHPCR(1) = PF(1) + PTCR : FFCR = RHPCR(1) * BETAH
1020 RHPCR(2)  = PF(2)  + PTCRSP  : FFCRSP = RHPCR(2) *
BETAH
1030 LOCATE 18,29: PRINT USING"### kts";TASCR
1040 LOCATE 20,3: PRINT USING"###,### SHP          ###,###
SHP";  PTCR,PTCRSP
1050 LOCATE 21,3: PRINT USING"###,### lb/hr        ###,###
lb/hr";FFCR,FFCRSP
1060 RETURN
1090 '
1100 '***  input    max  range  for  total  fuel reqmnt
**********************
1101 '
1103 LOCATE 23,1: PRINT SPC(77): COLOR 14,1
1105  LOCATE  23,10:  PRINT"4.  ENTER SPECIFICATION MAX
RANGE IN NAUTICAL MILES !": COLOR 15,1
1108 LOCATE 19,42: PRINT SPC(36)
1110 LOCATE 19,43: INPUT"4. SPEC MAX RANGE (NM) = ",MXR
1115 RETURN
1119 '
1120    '***      compute      total      fuel      required
**********************************
1121 '
1125 TIME = MXR/TASCR
1130                    TFUEL=(.1*BETAH*(SHP(2)+PF(1)))+
(.25*RHPMXE*BETAH)+ (TIME*FFCRSP)
1140 LOCATE 20,43: PRINT  USING" TOTAL  FUEL REQUIRED =
###,### lbs";TFUEL
1150 LOCATE  21,43: PRINT  USING"DESIGN FUEL CAPACITY =
###,### lbs";FUEL
1155 FUELDIF = ABS(TFUEL - FUEL)
1160 IF TFUEL < FUEL THEN 1165 ELSE 1170
1165 LOCATE 22,48:  PRINT  USING"          EXCESS  FUEL =
###,### lbs";FUELDIF : GOTO 1180
1170  LOCATE   22,48:  PRINT  USING"FUEL  DEFICIENCY  =
###,### lbs";FUELDIF
1175 LOCATE 1,1,0: ' PRINT"~W=FUELQUAN/"
1180 RETURN
1190 '
1200              '***                input              changes
*****************************************
1201 '
1205 LOCATE 23,1: PRINT SPC(77): COLOR 14,1
1210  LOCATE  23,5:  INPUT"ANY  CHANGES  ? (0=NO,1=YES)
",ANS
1220   IF ANS=0 THEN 1300 ELSE IF ANS=1  THEN 1230 ELSE
BEEP: GOTO 1200
1230 LOCATE 23,38: INPUT"WHICH ITEM (1 thru 4) ",X7
1235 IF X7 < 1 OR X7 > 4 THEN GOSUB 8000 :GOTO 1230
1240   COLOR 15,1:  ON X7 GOSUB 400,450,600,1100
1250      GOSUB  500:GOSUB  630: GOSUB 800: GOSUB 1000:
GOSUB 1120
1280 GOTO 1200
1290 '
1300 LOCATE 23,1: PRINT SPC(77): COLOR 14,1
1305 LOCATE  23,13:INPUT"press  <Shift-PrtSc>  for hard
copy, ENTER to continue",X5
1310  COLOR 15,1 :  GOTO 9000
8000 LOCATE  1,1,0: PRINT"~W=TRYAGAIN/"  : LOCATE 23,1:
PRINT SPC(77): RETURN
9000 CLS: PRINT"~W=LOADNOTE/": CHAIN"TR1",,ALL
9999 END
```

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